92/762
c

The Bancroft Library

University of California • Berkeley

Regional Oral History Office
The Bancroft Library

University of California
Berkeley, California

Western Mining in the Twentieth Century Series

George Conrad Heikes

MINING GEOLOGIST ON FOUR CONTINENTS

With an Introduction by
Evan Just

Interviews Conducted by
Eleanor Swent
in 1989 and 1991

Copyright ⓒ 1992 by The Regents of the University of California

Since 1954 the Regional Oral History Office has been interviewing leading participants in or well-placed witnesses to major events in the development of Northern California, the West, and the Nation. Oral history is a modern research technique involving an interviewee and an informed interviewer in spontaneous conversation. The taped record is transcribed, lightly edited for continuity and clarity, and reviewed by the interviewee. The resulting manuscript is typed in final form, indexed, bound with photographs and illustrative materials, and placed in The Bancroft Library at the University of California, Berkeley, and other research collections for scholarly use. Because it is primary material, oral history is not intended to present the final, verified, or complete narrative of events. It is a spoken account, offered by the interviewee in response to questioning, and as such it is reflective, partisan, deeply involved, and irreplaceable.

****

All uses of this manuscript are covered by a legal agreement between The Regents of the University of California and George Conrad Heikes dated 9 August 1989. The manuscript is thereby made available for research purposes. All literary rights in the manuscript, including the right to publish, are reserved to The Bancroft Library of the University of California, Berkeley. No part of the manuscript may be quoted for publication without the written permission of the Director of The Bancroft Library of the University of California, Berkeley.

Requests for permission to quote for publication should be addressed to the Regional Oral History Office, 486 Library, University of California, Berkeley 94720, and should include identification of the specific passages to be quoted, anticipated use of the passages, and identification of the user. The legal agreement with George Conrad Heikes requires that he be notified of the request and allowed thirty days in which to respond.

It is recommended that this oral history be cited as follows:

George Conrad Heikes, "Mining Geologist on Four Continents," an oral history conducted in 1989 and 1991 by Eleanor Swent, Regional Oral History Office, The Bancroft Library, University of California, Berkeley, 1992.

Copy no. ______

GEORGE CONRAD HEIKES
1948

Cataloging Information

Heikes, George Conrad (b.1900) Mining geologist

Mining Geologist on Four Continents, 1992, xi, 103 pp.

Mine geologist, Anaconda Company, Butte, Montana, 1924-1934; Giesche Mines, Poland, 1925-1934; chief geologist, National Lead Company; World War II: US Office of Production Management, Copper-Zinc Branch, and War Production Board, Zinc Division, Aluminum-Magnesium Division; post WWII: organizing geological survey in Greece, ECA (Marshall Plan); Agency for International Development, mine geology advisor in Korea, 1960-1964; directing survey of mineral resources in India for Ralph M. Parsons Company, 1967-1971.

Introduction by Evan Just, Professor Economic Geology, Emeritus, Stanford University.

Interviewed in 1989 and 1991 by Eleanor Swent for Western Mining in the Twentieth Century series. The Regional Oral History Office, The Bancroft Library, University of California at Berkeley.

TABLE OF CONTENTS--George Conrad Heikes

PREFACE i

INTRODUCTION--by Evan Just ix

INTERVIEW HISTORY x

BIOGRAPHICAL INFORMATION xi

I FAMILY AND EDUCATION 1
Maternal Grandfather, Louis Jules Sellier 1
Father, Victor Conard Heikes 2
International Exhibition, Paris, 1900 2
Paternal Grandfather, William Fletcher Heikes 3
Growing Up with Well-known Mining Men 4
Engineering at Lehigh 5

II THE ANACONDA COMPANY, 1924-1934 9
Trammer at the Leonard Mine, Butte 10
Introducing Geologic Mapping During Stope Sampling 11
Mine Geologist, Anaconda Group, Butte 12
The Giesche Mines, Poland, 1925 14
A Very High Grade Zinc Deposit 15
Settling a Dispute Over Stolen Ore 18
Mining Coal for Export to Seventeen Countries 19
Polish Coal and Silica Brick; a Poor Combination in Denmark 19
Problems with Polish Coal in Gottland 20
Improving Conditions in the Mines 21
Marriage to Margaret Chapman Judd 22
Foreseeing World War II 23

III PROFESSIONAL ACTIVITIES THROUGH WORLD WAR II 26
Reading Coal and Iron Company, 1935 26
Works Progress Administration and the Bureau of Mines, 1936-1937 27
Chief Geologist, National Lead Company, 1937-1940 28
Office of Production Management, Copper-Zinc Branch, 1941-1942 31
War Production Board, Zinc Division, 1940-1944 32
Saving the Calumet and Arizona Mine 32
Aiding Arabian Gold Mining 35
Olin Company, Tacoma Aluminum, 1943-1944 37
War Production Board, Aluminum-Magnesium Division, 1944-1945 39
Shutting Down Aluminum and Magnesium Plants 40

IV POST-WORLD WAR II ACTIVITIES 44
Vice President, Mines, Inc., Subsidiary of Ventures, Limited, Toronto, 1945-1948 44
Zellidja Lead Mine 44

Kennecott Copper Company, 1948-1949 46
Economic Cooperation Administration (Marshall Plan), Greece, 1949-1950 47
Organizing a Geological Survey in Greece 49
Greek Bauxite Mining; Arranging a Deal with the German Aluminum Industry 51
Getting Lignite Coal into Production for Electricity in Greece 51
Defense Materials Procurement Agency, Region IV, London, 1951 52
Ralph M. Parsons Company, Los Angeles, California, 1953 53
"Operation Hardrock," Surveying the Mineral Resources of India, 1967-1971 54
Aerial Mineral Survey 56
Partnerships Pacific, Australia, 1971-1973 59
Agency for International Development, Korea, 1960-1964 61
Increasing Production in the Coal Mines 62
Making New Geological Maps for Korea 65
More About Korean Mines 66
Getting Along with the Bureaucracy 68
Marriage to Myung Ja Yu 70
More About Examination of Mining Properties in Australia 72
Oracle Ridge, Arizona 72
Dilution of Ore; a Fundamental Problem in Some Mineral Resource Projects 74
Ethics and Mining Stock Sales 76

TAPE GUIDE 81

APPENDICES 82
A. Resume of George C. Heikes 83
B. "Operation Hardrock: A Mineral Exploration Project Based on Airborne Geophysics," by A.P. Subramaniam, 24th International Geological Congress, Canada, 1972. 86
C. Who's Who, 1944-1945, entry on Victor C. Heikes (father) 100

INDEX 101

PREFACE

The oral history series on Western Mining in the Twentieth Century documents the lives of leaders in mining, metallurgy, geology, education in the earth and materials sciences, mining law, and the pertinent government bodies. The field includes metal, non-metal, and industrial minerals, but not petroleum.

Mining has changed greatly in this century: in the technology and technical education; in the organization of corporations; in the perception of the national strategic importance of minerals; in the labor movement; and in consideration of health and environmental effects of mining.

The idea of an oral history series to document these developments in twentieth century mining had been on the drawing board of the Regional Oral History Office for more than twenty years. The project finally got underway on January 25, 1986, when Mrs. Willa Baum, Mr. and Mrs. Philip Bradley, Professor and Mrs. Douglas Fuerstenau, Mr. and Mrs. Clifford Heimbucher, Mrs. Donald McLaughlin, and Mr. and Mrs. Langan Swent met at the Swent home to plan the project, and Professor Fuerstenau agreed to serve as Principal Investigator.

An advisory committee was selected which included representatives from the materials science and mineral engineering faculty and a professor of history of science at the University of California at Berkeley; a professor emeritus of history from the California Institute of Technology; and executives of mining companies.

We note with much regret the death of two members of the original advisory committee, both of whom were very much interested in the project. Rodman Paul, Professor Emeritus of History, California Institute of Technology, sent a hand-written note of encouragement just a few weeks before his death from cancer. Charles Meyer, Professor Emeritus of Geology, University of California at Berkeley, was not only an advisor but was also on the list of people to be interviewed, because of the significance of his recognition of the importance of plate tectonics in the genesis of copper deposits. His death in 1987 ended both roles.

Thanks are due to other members of the advisory committee who have helped in selecting interviewees, suggesting research topics, and raising funds.

Unfortunately, by the time the project was organized several of the original list of interviewees were no longer available and others were in failing health; therefore, arrangements for interviews were begun even without established funding.

The project was presented to the San Francisco section of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) on "Old-timers Night," March 10, 1986, when Philip Read Bradley, Jr., was the speaker. This section and the Southern California section provided initial funding and organizational sponsorship.

The Northern and Southern California sections of the Woman's Auxiliary to the AIME (WAAIME), the California Mining Association, and the Mining and Metallurgical Society of America (MMSA) were early supporters. Several alumni of the University of California College of Engineering donated in response to a letter from Professor James Evans, the chairman of the Department of Materials Science and Mineral Engineering. Other individual and corporate donors are listed in the volumes. The project is ongoing, and funds continue to be sought.

Some members of the AIME, WAAIME, and MMSA have been particularly helpful: Ray Beebe, Katherine Bradley, Henry Colen, Ward Downey, David Huggins, John Kiely, Noel Kirshenbaum, and Cole McFarland.

The first five interviewees were all born in 1904 or earlier. Horace Albright, mining lawyer and president of United States Potash Company, was ninety-six years old when interviewed. Although brief, this interview will add another dimension to the many publications about a man known primarily as a conservationist.

James Boyd was director of the industry division of the military government of Germany after World War II, director of the U.S. Bureau of Mines, dean of the Colorado School of Mines, vice president of Kennecott Copper Corporation, president of Copper Range, and executive director of the National Commission on Materials Policy. He had reviewed the transcript of his lengthy oral history just before his death in November, 1987. In 1990, he was inducted into the National Mining Hall of Fame, Leadville, Colorado.

Philip Bradley, Jr., mining engineer, was a member of the California Mining Board for thirty-two years, most of them as chairman. He also founded the parent organization of the California Mining Association, as well as the Western Governors Mining Advisory Council. His uncle, Frederick Worthen Bradley, who figures in the oral history, was in the first group inducted into the National Mining Hall of Fame, Leadville, Colorado, in 1988.

Frank McQuiston, metallurgist, vice president of Newmont Mining Corporation, died before his oral history was complete; thirteen hours of taped interviews with him were supplemented by three hours with his friend and associate, Robert Shoemaker.

Gordon Oakeshott, geologist, was president of the National Association of Geology Teachers and chief of the California Division of Mines and Geology.

These oral histories establish the framework for the series; subsequent oral histories amplify the basic themes.

Future researchers will turn to these oral histories to learn how decisions were made which led to changes in mining engineering education, corporate structures, and technology, as well as public policy regarding minerals. In addition, the interviews stimulate the deposit, by interviewees and others, of a number of documents, photographs, memoirs, and other materials related to twentieth century mining in the West. This collection is being added to The Bancroft Library's extensive holdings.

The Regional Oral History Office is under the direction of Willa Baum, division head, and under the administrative direction of The Bancroft Library.

Interviews were conducted by Malca Chall and Eleanor Swent.

Willa K. Baum, Division Head
Regional Oral History Office

Eleanor Swent, Project Director
Western Mining in the Twentieth
Century Series

October 1990
Regional Oral History Office
University of California, Berkeley

Western Mining in the Twentieth Century Oral History Series
Interviews Completed, April 1992

Horace Albright, Mining Lawyer and Executive, U.S. Potash Company, U.S. Borax, 1933-1962, 1989

James Boyd, Minerals and Critical Materials Management: Military and Government Administrator and Mining Executive, 1941-1987, 1988

Philip Read Bradley, Jr., A Mining Engineer in Alaska, Canada, the Western United States, Latin America, and Southeast Asia, 1988

Catherine C. Campbell, Ian and Catherine Campbell, Geologists: Teaching, Government Service, Editing, 1989

James T. Curry, Sr., Metallurgist for Empire Star Mine and Newmont Exploration, 1932-1955; Plant Manager for Calaveras Cement Company, 1956-1975, 1990

James Mack Gerstley, Executive, U.S. Borax and Chemical Corporation; Trustee, Pomona College; Civic Leader, San Francisco Asian Art Museum, 1991

John F. Havard, Mining Engineer and Executive, 1935-1981, 1992

George Heikes, Mining Geologist on Four Continents, 1992

Helen R. Henshaw, Recollections of Life with Paul Henshaw: Latin America, Homestake Mining Company, 1988

Lewis L. Huelsdonk, Manager of Gold and Chrome Mines, Spokesman for Gold Mining, 1935-1974, 1988

Arthur I. Johnson, Mining and Metallurgical Engineer in the Black Hills: Pegmatites and Rare Minerals, 1922 to the 1990s, 1990

Evan Just, Geologist: Engineering and Mining Journal, Marshall Plan, Cyprus Mines Corporation, and Stanford University, 1922-1980, 1989

Plato Malozemoff, A Life in Mining: Siberia to Chairman of Newmont Mining Corporation, 1909-1985, 1990

James and Malcolm McPherson, Brothers in Mining, 1992

Frank Woods McQuiston, Jr., Metallurgist for Newmont Mining Corporation and U.S. Atomic Energy Commission, 1934-1982, 1989

Gordon B. Oakeshott, The California Division of Mines and Geology, 1948-1974, 1988

Vincent D. Perry, A Half Century as Mining and Exploration Geologist with the Anaconda Company, 1991

James V. Thompson, Mining and Metallurgical Engineer: the Philippine Islands; Dorr, Humphreys, Kaiser Engineers Companies; 1940-1990s, 1992

Interviews In Process, April 1992

Samuel S. Arentz, Jr. (Escalante Mine), in process

Donald Dickey (Oriental Mine), in process

Ward J. Downey (mining, construction engineering), in process

H. S. Pete Fowler (Kaiser), in process

Wayne Hazen (metallurgy), in process

James Jensen (metallurgy), in process

John Livermore (geologist), in process

Carl Randolph (U.S. Borax), in process

John Reed (rock mechanics), in process

Joseph Rosenblatt (EIMCO), in process

Eugene Smith (U.S. Borax), in process

Langan Swent (San Luis, Homestake, uranium mining), in process

ADVISORS TO THE SERIES, WESTERN MINING IN THE TWENTIETH CENTURY

Professor Douglas Fuerstenau, Principal Investigator
Plato Malozemoff Professor, Department of Materials Science and
Mineral Engineering, University of California, Berkeley

Robert R. Beebe
Senior Vice President (retired),
Homestake Mining Company

Mr. Philip R. Bradley
Former Chairman, California State
Mining and Geology Board

Henry Colen
President, San Francisco Mining
Associates

Professor Neville G. Cook
Department of Materials Science and
Mineral Engineering, University of
California, Berkeley

J. Ward Downey
Engineering and Industrial
Management Consultant

Professor Roger Hahn, Department of
History, University of California,
Berkeley

Mr. John Havard
Senior Vice President (retired),
Kaiser Engineers, Inc.

Mr. Clifford Heimbucher, C.P.A.
Consultant, Varian Associates, Inc.

Mr. John R. Kiely
Senior Executive Consultant
(retired), Bechtel, Inc.

Noel Kirshenbaum
Manager, Mineral Products
Development, Placer Dome U.S.

Plato Malozemoff
Chairman Emeritus, Newmont Mining
Corporation

Mr. Joseph P. Matoney
Vice President (retired)
Coal, Kaiser Engineers, Inc.

Mrs. Donald H. McLaughlin
Founder, Save San Francisco Bay
Association

Professor Malcolm McPherson
Massey Professor of Mining
Engineering, Virginia Polytechnic
Institute and State University

*Professor Emeritus Charles Meyer,
Department of Geology, University of
California, Berkeley

Professor H. Frank Morrison
Chairman, Department of Materials
Science and Mineral Engineering,
University of California, Berkeley

Professor Joseph A. Pask
Department of Materials Science and
Mineral Engineering, University of
California, Berkeley

*Professor Emeritus Rodman Paul,
Department of History, California
Institute of Technology

Mr. Langan W. Swent
Vice President (retired), Homestake
Mining Company

* Deceased during the period of the
project

The Regional Oral History Office
would like to express its thanks to the organizations
and individuals whose encouragement and support have made possible
The Western Mining in the Twentieth Century Series.

DONORS
TO
THE WESTERN MINING IN THE TWENTIETH CENTURY
ORAL HISTORY SERIES
1986-1992

Organizations

American Institute of Mining, Metallurgical, and Petroleum Engineers, San Francisco and Southern California Sections
Woman's Auxiliary to the AIME, Southern California and Northern California Sections
California Mining Association
The Jackling Fund of the Mining and Metallurgical Society of America

Corporations

Bechtel Group Incorporated
Cyprus Minerals Company
Freeport-McMoRan
EIMCO Process Equipment Company
Homestake Mining Company
Kennecott Corporation
Krebs Engineers
Newmont Mining Corporation
United States Borax & Chemical Corporation

Patrons

James Boyd
Barbara H. and James T. Curry, Jr.
Donald Dickey
J. Ward and Alberta P. Downey
James M. Gerstley
Mrs. Paul C. Henshaw, in memory of her husband, Paul C. Henshaw
Arthur I. Johnson
Dean A. McGee
Mrs. Frank W. McQuiston, Jr., in memory of Frank W. McQuiston, Jr.
Gordon B. Oakeshott
Vincent D. Perry
Plato Malozemoff Foundation
Public Resource Foundation
Joseph Rosenblatt
Langan and Eleanor Swent

Individuals

Claude J. Artero
Clemence DeGraw Jandrey Boyd
Philip and Katherine Bradley
Catherine C. Campbell
Albert T. Chandler
Stanley Dempsey
Mr. and Mrs. Douglas Fuerstenau
Louis R. Goldsmith
Mrs. Bruce S. Howard, in memory of
   Henry Harland Bradley
Lewis L. Huelsdonk
Howard Janin
James H. Jensen
Jack M. Jones
Evan Just
James C. Kimble
Noel W. Kirshenbaum
Plato Malozemoff
Sylvia C. McLaughlin, in memory of
   Jay Kimpston Swent
L. Arthur Norman, Jr.
Richard W. Rees
Richard M. Stewart
Simon D. Strauss
John R. Struthers
James V. Thompson
William I. Watson
William B. Whitton

INTRODUCTION--by Evan Just

George Heikes and I have been friends ever since he came back from Silesia fifty-five years ago, but he has been abroad and afield for most of that time. Thus, my awareness of his accomplishments has been tenuous. In reading the details of his resume I was surprised and impressed--enough responsible positions for three of four estimable careers and enough examinations as a consultant for at least two!

I have always thought of George as a man who preferred to work in the field rather than sit at a desk--never mind the designer clothes or the size of the office desk; get the job done. He is a man who, if given an assignment, would get it done if it were amenable to effort and perseverance. In this vein, although we never discussed his Kennecott days, I can imagine his frustrations, because I remember his boss, Anton Gray, telling me that the company would not consider prospects that could not be expected to yield profits of $25 million per year. What a target to place an exploration team behind the eight ball!

I vividly remember the wartime days when George and John Church "managed" the Copper-Zinc Branch of the War Production Board. (The word "managed" is in quotes because the whole condition was a maelstrom and no part was truly manageable.) The metal branches participated in the allocation of metals to industrial consumers and were also charged with getting needed supplies to the producers. In those early days when the Board was trying to operate in a priority system that did not equate demand to supply, and quickly became swamped in its own procedures. Every application had to pass a number of check points and the desks of the decision makers became stacked with piles of applications going nowhere. George became a hero to the copper and zinc people by simply taking their applications and running them through the mill personally, hounding the decision makers until they signed. He got the job done!

Evan Just, Professor Emeritus,
Stanford University; former Vice
President, Cyprus Mines; former
Editor, Engineering & Mining Journal;
former Director, Strategic Materials
Division, ECA (Marshall Plan)

20 June 1990
Menlo Park, California

INTERVIEW HISTORY--George Conrad Heikes

George Conrad Heikes was chosen to be interviewed for the oral history series on Western Mining in the Twentieth Century because he is the senior Distinguished Member of the Society for Mining, Metallurgy and Exploration [SME] of the American Institute of Mining, Metallurgical, and Petroleum Engineers [AIME].

He could hardly have escaped a career in mining. His maternal grandfather was a mining engineer and geologist who taught at the Colorado School of Mines. George Heikes was born in 1900 in Paris, where his father, Victor Heikes, representing the U.S. Geological Survey, was in charge of the American mining display at the International Exposition.

George Heikes grew up in Salt Lake City, graduated from Lehigh University in Pennsylvania, and in 1924 began working for the Anaconda Mining Company in Butte, Montana. He was transferred to base metal and coal mines in Poland, and later directed geology and exploration for Anaconda in Europe. During World War II, he headed U.S. government production agencies for copper, zinc, magnesium, and aluminum. Following the war, he worked for ECA (the Marshall Plan) aiding the reconstruction of the mineral industry in Greece, and AID as advisor for mines in Korea. He was chief geologist for National Lead Company, assistant vice president of Kennecott Copper Corporation, and vice president of Mines, Inc. He worked for Ralph M. Parsons Company, directing an aerial survey of the mineral resources of India.

Mr. Heikes was first interviewed at his home in San Jose, California, in August 1989. The review of this transcript was interrupted by the Loma Prieta earthquake in October. Interviews were re-recorded on 1, 2, and 10 August 1991. The lightly edited transcript was sent to Mr. Heikes for review, and returned with many stylistic changes.

The introduction is by Evan Just, a contemporary and long-time associate, emeritus professor of economic geology at Stanford.

The tapes of the interview are available for study at The Bancroft Library, University of California at Berkeley.

Eleanor Swent, Interviewer-Editor

March 1992
Regional Oral History Office
The Bancroft Library
University of California, Berkeley

Regional Oral History Office
Room 486 The Bancroft Library

University of California
Berkeley, California 94720

BIOGRAPHICAL INFORMATION

(Please write clearly. Use black ink.)

Your full name George Conrad Heikes

Date of birth September 5, 1900 Birthplace Paris, France

Father's full name Victor Conard Heikes

Occupation Statistician/Historian Birthplace Dayton, Ohio

Mother's full name Anna Marie Sellier

Occupation Home maker Birthplace Paris, France

Your spouse Ruth Margaret Chapman 31 yrs. Yu, Myung Ja 25 yrs thus far

Your children Barbara + Tom Judd Yu Ro Lee

Where did you grow up? Salt Lake City, Utah

Present community 112 Douglane Ave, San Jose, CA. 95117

Education Salt Lake High School. Mercersburg Academy, Mercersburg, Penna., Lehigh University, Bethlehem, Penna.

Occupation(s) Retired

Areas of expertise Mining Geologist

Other interests or activities

Organizations in which you are active

I FAMILY AND EDUCATION

[Interview 1: August 1, 1991]##[1]

Swent: Mr. Heikes, let's just start at the beginning. Perhaps you want to tell us a little bit about your grandfather and your father.

Heikes: I got into mining by inheritance and propinquity. I was born in Paris, France, September 5, 1900. My father was in charge of the American mining exhibit at the International Universal Exhibition in Paris in 1900.

Maternal Grandfather, Louis Jules Sellier

Heikes: My maternal grandfather was Louis Jules Sellier. He was the mining and metallurgical engineer for the Rothschilds in Paris. He bought the Boleo Mine in Baja California for the Rothschilds. It operated up until recently when it was taken over by the Mexican government.

Swent: What was it mining?

Heikes: Copper. He was also connected with the BOR copper mine and smelter in Serbia. BOR and Boleo were in the same mining company in Paris.

Swent: Was he French himself? He was from France?

Heikes: He was French, yes. He spoke many languages. He spoke and wrote Spanish and French, German and English. I think he was able to get along in Serbian and Russian.

---

[1] This symbol ## indicates the start of a new tape or tape segment. For a guide to the tapes, see page 81.

Swent: Did you know him?

Heikes: I just met him when he was about eighty-eight years old, puttering around his garden in Alameda, California. He didn't like my mother because she was his youngest daughter and he wanted a boy. He never lived long enough to see whether his grandson amounted to anything or not.

Instead of retiring, he was teaching metallurgy at Golden [Colorado School of Mines]. At the same time my father was a student there; my mother was a little girl running around in the garden.

Swent: That's how they met.

Heikes: That's how they met.

Father, Victor Conard Heikes

Swent: And your father then became a chemist and assayer?

Heikes: My father took courses in chemistry and assaying at the Colorado School of Mines and studied geology. He visited a great many mines in the western states. Waldemar Lindgren of the U.S. Geological Survey appointed my father in charge of the Salt Lake City, Utah, office of the USGS to write up the history and compile annual statistics on production from each of these mines. Dr. Lindgren was interested in segregating production information from different types of mineral deposits such as veins near igneous bodies, replacement deposits, and so forth.

Swent: When did your father graduate from the Colorado School of Mines?

Heikes: He graduated from the school of mines in 1891. And then he started an assay office in Boulder, Colorado, about the time of a tungsten boom, "Heikes and Watts Assay Office, Assayers and Chemists."

Swent: It must have been quite unusual to be a graduate of a mining college at that time. There were not a lot of people who actually graduated from college.

Heikes: He was enthusiastic, appreciated the opportunity, and worked hard.

International Exhibition, Paris, 1900

Swent: So how did he happen to be in Paris in 1900?

Heikes: My father had been a curator at the Chicago Field Museum, where he gained experience in setting up exhibits. Some of his influential friends recommended him for that position, friends who knew about his experience. He was with the U.S. Geological Survey in their Salt Lake City office when they borrowed him to go over to Paris. He was able to borrow a stope from the Copper Queen Mine in Bisbee, Arizona, with colorful copper minerals, gold nuggets from California, and assembled a colorful collection of minerals from many different places. He borrowed equipment and mining and milling machinery from the United States manufacturers to be exhibited at the Paris Exposition. After the exhibition he returned the items borrowed.

I think he once told me they had loaded this stuff on the Polaris, an old warship, hauled it over to Paris and returned it to the owners afterwards. There was a special building erected for mining. As a side issue, it is interesting to note that the Eiffel Tower had cost about a million dollars and had been built for the Paris Exposition. Years before that my Grandfather Sellier had purchased the Boleo Copper Mine in Baja California, Mexico, for the Rothschild Bank in Paris and paid one million dollars in U.S. gold coins for the property.

Swent: This is your maternal grandfather who had paid that.

Heikes: Yes. Years later, he chose to teach metallurgy at the Colorado School of Mines in Golden, at the same time my father was a student there, and that is how my father met my mother, Professor Sellier's youngest daughter, Anna Marie.

Paternal Grandfather, William Fletcher Heikes

Heikes: My paternal grandfather was a nurseryman. He was general manager of the largest nursery in the world, the Huntsville Wholesale Nursery, Huntsville, Alabama, where he had two thousand acres under cultivation. He was also president of the American Horticulture Society and president of the American Nurseryman's Association. His partner was a mining engineer, Milton Moss, a graduate of Heidelberg and the Mining School at Clausthal, Germany.

For a short time, Milton Moss was appointed acting president of the Colorado School of Mines at Golden. During his tenure there he engaged Regis Chauvenet of St. Louis as president. Mr. Chauvenet was president for many years and is said to have made an outstanding contribution in his management of the School of Mines.

When I was going to Lehigh University in Bethlehem, Pennsylvania, many years later, 1919 to 1923, Milton Moss helped me financially. I don't know but I assume he must have exerted his influence to get my father interested in going to a mining school.

Swent: Was there a good deal of mining in Alabama?

Heikes: Chiefly bituminous coal mining but neither Milton Moss nor my father did any coal mining. My father was always in metal mining, like gold. He was superintendent of the first mill in Utah to use the cyanide process to recover gold at Mercur, Utah.

Swent: He was mill superintendent?

Swent: He was superintendent of the Sunshine Mill.

Swent: Was this before he went to Paris?

Heikes: I was born in Paris. I came back here when I was nine months old. I've been American since September 5, 1900.

Swent: Your upbringing was in Utah.

Growing Up with Well-known Mining Men

Heikes: I was brought up in Utah. My father knew the mining men in the Salt Lake City area, including D.C. Jackling and Lafayette Hanchett of the Utah Copper Company.

Swent: Did you know them well?

Heikes: I knew Mr. Jackling, Hanchett, Louis Cates, and others.

My first trip out to the Utah Copper Mine was about 1907. I rode out there with Louis Cates, who was mine superintendent. He later became president of Phelps Dodge. While at Utah Copper Company, he had an office in a caboose hooked on the end of an ore train.

When I rode out to Utah Copper with Mr. Cates, the mine was a mountain; it wasn't a pit yet. It was quite a high mineralized mountain. They used old steam shovels purchased from the Iron Range in Minnesota in the beginning of [its] mining.

Swent: Was it underground mining?

Heikes: No, it was all surface mining. Now, of course, it's a huge deep pit.

Swent: Yes, one of the biggest.

Heikes: Have you ever been there?

Swent: Yes, but a long time ago.

Heikes: I saw it when it was beginning and many times over the years. It made quite an impression on me as a little boy; today it is one of the wonders of the world.

The geologist who prepared the U.S.G.S. Professional Paper on Bingham, Utah, was John M. Boutwell, graduate of Harvard. He had also mapped the Park City District. He produced the U.S.G.S. professional papers on Park City and Bingham. He was a close friend of my parents. I called him my Uncle John.

Then, Dr. Lindgren came to Salt Lake frequently and was always a guest at our house at those times along with Donnel Foster Hewett, Charles Will Wright, Thomas B. Nolan, Frank Hess, and many other mining and geological experts from the U.S. Geological Survey, U.S. Bureau of Mines, and mining industry.

Swent: So you heard a lot of talk about mining.

Heikes: Sure did. With my father and mother both interested in mining, and my being brought up in Salt Lake, located between Park City and Bingham, that's about all I heard. It was natural that I should follow mining.

Engineering at Lehigh

Heikes: At first, I wanted to be an electro-metallurgist. I wanted to go to M.I.T. but my mathematics were so bad I couldn't get in. I was able to get into Lehigh by taking the business course my first year and taking algebra with the engineers in my second year, or freshman year in the engineering program. In Salt Lake High School, I had not applied myself as diligently as I should have in algebra so I was backward in math. But I got caught up to date at Lehigh, when I took algebra with the engineers.

In my third or junior year, I was having financial problems, and the professor of metallurgy, Joseph W. Richards, died. I had done exceptionally well in my courses in geology so rather than put in another year in engineering, I decided to use my credits for a B.A. in geology, get a job, and start earning a living.

Swent: When was this?

Heikes: In 1922.

Swent: Had the war affected your education?

Heikes: No. A good many of my classmates had come back from the First World War and were mature individuals. During 1918, I had a summer job as a chemist in Cleveland, Ohio, working for the Grasselli Chemical Company. Grasselli was taken over by Dupont.

Swent: This was a summer job?

Heikes: Yes. A summer job. Grasselli purchased lead-zinc concentrates from mining companies and roasted the concentrates to produce sulfuric acid of different grades. My job was to see how much sulfur was still left in the calcine cake after they roasted the concentrates. I also made zinc, lead, and copper determinations.

Swent: You started with zinc pretty early in your life.

Heikes: In 1918, yes.

Another summer job. The next summer job after Cleveland was in Park City, Utah, working at the Judge Electrolytic Zinc Plant. I wrote a description of that plant that was published in the Engineering and Mining Journal in December, 1920.

I was at Lehigh when this was published. The professor of metallurgy, Joseph W. Richards, asked me, "Are you any relation to this George C. Heikes who wrote this article on electrolytic zinc in Park City?" The Judge Electrolytic Zinc Plant was one of the first plants of its kind in the world. I said, "Yes, I did it."

Swent: You did it on your own, then. You didn't do it as part of a school project.

Heikes: No, no. I did it on my own. What happened really was that the western editor of E&MJ, George J. Young, visited the plant and took a lot of photographs. I said, "I wrote up an article on this plant for my own record."

He said, "Can I have it?"

I said, "Sure." Then he wanted to know if he could publish it. I said, "If I can get permission from the management, it's all right with me." That was how it all came about.

Swent: You were very young to have an article published in E&MJ.

Heikes: I was a freshman and living in the Phi Gamma Delta House at Lehigh. Many of my colleagues were senior class miners or metallurgists.

Professor Richards bawled them out. He said, "Here he is a freshman. You know freshman year is the toughest year around here, but he has time to write an article on electrolytic zinc and the rest of you fellows are complaining about the assignments I give you." So I was in the dog house for a little while.

Well, that's so much for that.

Swent: You graduated from Lehigh, then?

Heikes: My senior year, I ran out of money. My grandfather's partner, Milton Moss, who had been helping me financially to go through college, had a prostate operation at Johns Hopkins University Hospital in Baltimore. After the operation I accompanied him to his home in Huntsville, Alabama, to take care of him.

At Lehigh, if you ever started anything you had to finish it. I had started a course in philosophy and I had also started taking German because the professor of metallurgy insisted that I learn German so that I could read German literature, because he said that most of the literature those days on metallurgy was written in the German language, so you had to be proficient in German in order to understand what was going on in the world. I started German. Having started it, I had to take two years of it.

While I was in Alabama taking care of my uncle, I translated a book from German into English. I read another book on philosophy, took a test, and passed it all right. So I got a diploma. I had gotten very high marks on all of my elective studies in geology, so I was able to get a B.A. in geology in 1923.

Swent: It's interesting that even after the war the technical material was still in German.

At the time you graduated from Lehigh, you were living in Alabama?

Heikes: When I was going to Lehigh, my home was in Salt Lake City. They mailed my diploma to me. Although I was secretary of my class of 1923, I wasn't present at the commencement since I was with Mr. Moss at Johns Hopkins Hospital.

Swent: Then you went back to Salt Lake. Did you begin to work there then?

Heikes: No. When I left Alabama, I went to Butte, Montana.

II THE ANACONDA COMPANY, 1924-1934

Swent: How did you happen to go there?

Heikes: I had been exposed to quite a lot of metallurgy when I was at Lehigh. My father said, "Can you read a mining engineer's report?"

I said, "Sure, I can read it."

He said, "Can you go out and check it?"

I said, "No, I couldn't do that." He said, "Unless you can do that, you'll never be much good in the mining profession because the world is peppered with mills and smelters where they didn't have the ore to put in them after they built them." That's true.

I said, "Where can I learn that? You don't learn it in college."

He said, "If you can get a job with Reno Sales, up in Butte, with the Anaconda Copper Company, you might learn some of it there."

So I went home to Salt Lake from Alabama and I telephoned Anaconda in Butte and talked to Mr. Sales. He said, "No use coming up here. We don't need anybody."

Swent: Did he know your father? Had you met him already?

Heikes: No, they didn't know each other. I said, "I'm coming up anyway." So I got on a train, I went up to Butte and went into his office.

He said, "We don't have anything."

I said, "How about a sampler?"

"No," he said, "we're all filled up on that too."

I said, "What am I going to do? I'm here."

"Well," he said, "you can get a job underground. We always need husky fellows like you."

Trammer at the Leonard Mine, Butte

Heikes: So I went down to the Leonard Mine and I got a job as a trammer pushing a car in one of the lower levels of the Leonard Mine. While I was on that job, there was a cave-in on one of the levels and I was assigned to assist a timberman in getting the mess straightened up.

Swent: Were people hurt in this accident?

Heikes: No. Then, a little later one of the contract miners on that level, his partner got sick and he asked the shift boss if he could get me to help him. So I went mining for a while and made seven dollars during an eight-hour shift as a contractor. After his partner got well, I went back to pushing a car for three dollars and a half for an eight-hour shift.

Swent: Where did you live in Butte?

Heikes: Y.M.C.A. I used to come home from work and wrestle for a couple of hours in the evening. At the Y.M.C.A. This man I was wrestling with, named Walter Freshman, said, "What are you doing?"

I said, "I'm a trammer down at the Leonard Mine."

He said, "Why don't you go sampling?"

I said, "They told me that there were forty men ahead of me and it would take a couple of years to get a job."

He said, "We can fix that up." He turned out to be the assistant chief sampler. They put me on the next day as a stope sampler at the Anaconda Mine.

##

Heikes: I replaced Eddy McGlone, who was the first stope sampler in Butte, because he wanted to go back to Colorado. Years later he became vice president in charge of mining for Anaconda in the New York office.

Introducing Geologic Mapping During Stope Sampling

Swent: The idea of stope sampling was new then?

Heikes: Yes. I was the first regular stope sampler at the Anaconda Mine.

Swent: What had they done before that?

Heikes: Didn't have one.

Swent: Just didn't sample at all.

Heikes: The shift boss directed the mining.

On account of being a bachelor and having nothing else to do in the evening, I was compiling the results of my sampling work one night in a shack where I worked on the edge of the Anaconda dump. A big, fine-looking man came in about 10 p.m. and said, "What are you doing?" I showed him. He turned out to be Jim Kerrigan, who was superintendent of the Anaconda group of mines.

I showed them how they were loading a lot of waste in the bins to improve their tally for tons per shift. I said, "It's too bad, because we're selling copper and not rock." I also began to map the geology on the stope maps as I worked around through the mines. The result was I could see visually what I was talking about statistically.

Swent: The geologists at that time were not doing this?

Heikes: Not doing anything in the stopes, no. They were just on the development phase. There weren't many geologists either.

Swent: But Reno Sales was beginning to build up his geological staff.

Heikes: It was pretty early in the game. There were four or five geologists. Vin Perry,[1] Chester Steele, J.B. Gowen, Murl Gidel.

Swent: Vin Perry was there.

Heikes: At the Mountain Con[solidated], and I was at the Anaconda Group. J. B. Gowan was at the Leonard. Only a dozen of us all together. Chester Steele was at the Badger Mine. That was just about it.

Anyway, as a result of this stope mapping, the company engaged sixty stope samplers. I trained some of them.

---

[1] Vincent Perry, A Half Century of Mining and Exploration Geologist with the Anaconda Company, Regional Oral History Office, University of California, Berkeley, 1991.

Swent: The idea was to mine less waste.

Heikes: Mine less waste and raise the grade of ore.

Swent: This is always a problem, isn't it?

Heikes: That's always been the problem everywhere.

Swent: Were the men paid according to how many tons they produced?

Heikes: They were paid around $3.50 for an eight-hour shift regardless of production.

This stope sampling took me into most of the mines in Butte that were then operating, including the Badger which adjoined the Elm Orlu belonging to the Clark interests. In 1924 there was a lawsuit over the Poser Vein at the Badger Mine. Some of the leading geological consultants in the United States were engaged in lawsuits. In those days, the mining law prescribed that if you had an outcrop, you could follow it to China through all the dips and angles.

There were extra-lateral right lawsuits. This particular case was between the Elm Orlu Mine and the Poser Vein in the Badger Mine. Anaconda engaged Dr. Waldemar Lindgren as its geological consultant. I was assigned to be his assistant to do underground mapping for him on the mine workings he proposed for the lawsuit. That's how I got to know him very well.

Swent: Did you get in on the trial?

Heikes: I worked on the case. Anaconda made court models showing the mining work done to win their case in court. But I was not present at these hearings as I had been assigned to a subsidiary of Anaconda in Poland.

Mine Geologist, Anaconda Group, Butte

Heikes: But the interesting thing is, when I quit working underground at $3.50 a day, I was hired as a geologist at $135 a month. I told them, "By the time I get to be president of this company, I'll be paying you $50,000 a year for the privilege." [laughter] Imagine that, going from $3.50 a day as a trammer to $135 a month as a geologist.

Swent: That worked out to about how much a day, then?

Heikes: Well, let's see. I don't think I ever figured it out.

Swent: Was this a lot more than you had been making underground?

Heikes: Yes, just about. Let's see. Twenty-five working days. I ought to be able to do this in my head but nothing's working in my head very well. Yes, that was quite a raise from $87.50 to $135.00. That was pretty good.

Swent: You were pretty pleased with that.

Heikes: Yes, I was delighted.

Swent: How much did it cost to live at the Y?

Heikes: Not very much.

Swent: Where did you board? Did you eat at the Y also?

Heikes: No. I ate around town. You could get a roast beef sandwich for thirty-five cents and you could get a sirloin steak for a dollar. The cost of living was very low at the time.

Swent: So $3.50 was something you could live on then.

Heikes: It was a very good wage, yes. Compared to today, it's nothing. But then it was quite a lot and I was able to save some money even at $3.50 per day wages.

Swent: Did you get any sort of benefits?

Heikes: No. None whatsoever. Fortunately didn't need any either.

Swent: You were young and healthy.

Heikes: Yes. I was very strong, fortunately.

Swent: Yes, you would have to be. Were there labor troubles at Butte at that time?

Heikes: Yes, quite a few. We had the International Workers of the World in there. You were supposed to be a member of the union if you wanted to work there. I never became a member of any union.

Swent: How did you manage that?

Heikes: Just didn't.

Swent: You could work without joining the union.

Heikes: I just got away with it, I guess. I was very unpopular but that didn't make much difference. I was unpopular anyway.

Swent: Butte has always had a history of labor difficulties, hasn't it?

Heikes: They were having lots of them then. They had some pretty tough working conditions. I didn't find them tough but a lot of people did. I don't know any better. When you're young and healthy, a lot of things don't bother you at all. I didn't have to support anybody except myself. I didn't spend much money. I was very careful with my money.

Swent: Three and a half a day to support a family on wouldn't go very far.

Heikes: Not very far. Not even very far then. That was a poverty-stricken setup for most of the miners. I was in the class of '23; Lehigh mailed my diploma to me in 1924.

In 1925, a huge lead-zinc mining and smelting situation came to Anaconda's attention over in Poland. Mr. Sales asked everybody in the geological department if they would go over to Poland to help examine the mining properties. Murl Gidel was selected to do the geology and I agreed to go over there to help sample the ore body.

The Giesche Mines, Poland, 1925

Swent: That is, Anaconda acquired a mine in Poland.

Heikes: No, they hadn't acquired it yet. We'll get back to 1925.

In 1925, Reno Sales and Frederick Laist, the metallurgical manager at the Anaconda smelter--he was the general manager at Anaconda Smelter and Reno was chief geologist in Butte.

Swent: You were working under Reno Sales.

Heikes: I was working under Reno Sales. In 1925, Sales and Laist were sent over to Poland to examine the property that had been offered Anaconda that was in distress after World War I. This certain property was turned over to Poland from Germany. Sales and Laist reported, "It's a worthwhile property. We would like to make a thorough examination." They set up an examining staff consisting of--. Do you want to write these names down?

Swent: Yes.

Heikes: Chauncey Berrian. He was general superintendent of mines in Butte and a graduate of Columbia, 1901, a right-end football player. He was in charge. Ernest Klepetko, metallurgist from Anaconda Smelter. Martin Messner. His son is in San Francisco now.

Swent: Yes. I think he lives in Walnut Creek.

Heikes: Gilbert Wegner, a chemist. Frederick P. Gaethke. He had been in charge of U.S. Bureau of Mines Car Number Nine. In those days, the Bureau of Mines had emergency cars at all the main mining camps in case of a mine disaster. Where they had trained men who could go underground with equipment for fighting fires and other kinds of catastrophes. He was in charge of Car Number Nine and a graduate of the Montana School of Mines at Butte. Gaethke had been a sergeant major with the U.S. Army over on the Siberian railroad and could speak some Russian. Russian and Polish are both Slavic languages. He was also fluent in German.

Then Murl Gidel, who was a geologist on the staff of Anaconda, and George Heikes were selected as samplers. Let's see, I've got Klepetko, Messner, Wegner, Heikes, Gaethke, and Berrian. The six of us went over to Poland to examine this mine. We were underground forty days. I went underground when it was night and came up at night. As I told you the other day, this was one of the richest zinc mines I ever saw in my life.

A Very High Grade Zinc Deposit

Swent: Please tell about that again.

Heikes: We would take samples of ten feet of 70 percent zinc, mostly wurtzite, which is a zinc sulfide mineral. The mill was treating about 2,000 tons per day, averaging 17.5 of zinc and 2.5 percent lead.

Swent: Did you have anything to do with the mill at all?

Heikes: No. Messner did that.

Swent: You were only underground.

Heikes: I was just on the underground sampling work.

Swent: What sort of methods were they using for mining?

Heikes: It was a local room-and-pillar method. It was an almost flat-lying deposit, almost like a coal mine, only you didn't have the same problems that you have in a coal mine. The mine had a very weak and faulted back and we had a lot of problems with cave-ins and so forth. We had to be very careful all the time. Big chunks of dolomite, faulted in every which direction, would drop down unexpectedly. Sometimes, they would squash everything underneath, including human beings if they happened to be there. They killed quite a few men that way. One of the toughest jobs I ever had anywhere in my life was to visit a family after their man and chief was killed, and tell his family about it.

Swent: That's awful.

Heikes: Anyway--.

Swent: Did Anaconda take this over?

Heikes: Anaconda took over that property. They sold Silesian-American bonds, matured in 1947.

Swent: That would have been twenty years?

Heikes: Yes. Twenty-year bonds. I don't know what the interest rate was, but they raised about twenty million dollars, of which they gave seven million dollars to the German side to build a mill. They loaned them seven million dollars. They spent the balance fixing up the properties on the Polish side.

Swent: This was right on the border, then.

Heikes: Yes. I'm ahead of the story. I was telling you about the difficulty they had in establishing a border. They had these plebiscite votes among the people. The map looked like a Dalmatian dog with spots here and there, clusters of people who wanted to be Polish and clusters of people who wanted to be German. They had a mixed commission, consisting of Germans, Polish and Swiss, to decide where to put the border. This border eventually went right down through the richest part of the ore body, which was on the German side of the line; the poorest ore was on the Polish side of the line with all the mills and smelters also on the Polish side. So we had to loan the Germans the money to build on the German side.

Swent: The Poles just happened to get the poorer part of the ore deposit.

Heikes: Poland got all that ore deposit and plants for nothing.

Swent: But they got the poorer ore.

Heikes: Well, Poland got the poorer ore but there was a lot of it and it was high grade. In the Polish ore reserves was seven million tons of recoverable zinc for example.

Swent: So there was a lot of it even though it was lower grade.

Heikes: Yes. The assay grade was about 21 percent. The mining grade was 17.5 percent zinc and 2.5 lead as I mentioned before.

Swent: Then on the German side--.

Heikes: On the German side, it was a much higher grade ore. I had no reason to pay much attention to that.

Swent: You were working on the Polish side.

Heikes: On the Polish side only.

Swent: What sort of machinery or equipment did they use for mining?

Heikes: They used compressed air augur drills and hand-operated augur drills. It was soft ore, relatively speaking.

Swent: One man on one drill.

Heikes: One man on a drill, and hand shovelling. The mines were not mechanized at all.

Swent: What kind of cars?

Heikes: Little round-bottomed one-ton cars on an eighteen-inch track.

Swent: The men just pushed them? Trammers?

Heikes: Pushed them, yes. Except out on the main haulage where we had heavy rails and locomotives. They made up trains out there in the main haulage but they used these little one-ton cars in the stopes.

Swent: How deep were the mines?

Heikes: About 350 feet below the surface in a fairly flat-lying deposit, dipping about four or five degrees to the north. The Polish ore body was on the slope of a gentle syncline.

Settling a Dispute Over Stolen Ore

Heikes: An interesting thing here. You don't have to record this, but this rich Giesche Company that I was working for, that Anaconda took over, had mined some ore from the adjoining property which was owned by Prince Hohenlohe. There was an argument about this and I had to settle the thing, which I did.

Swent: How did you do that?

Heikes: By careful mapping and deciding what grade of ore must have been in the stopes that were stolen and so forth. It reminded me of this business over in Kuwait and Iraq. That was the same thing there. Iraq and Kuwait had the same oil field. You couldn't tell who was stealing off of whom, but they could have settled it by negotiation without sending all these American troops over. It was a ridiculous thing, in my opinion. I was asked the other day what I thought of the Desert Storm situation. I said it was quite unnecessary, in my opinion. They could have settled the thing as I settled this dispute in Poland.

Swent: What was the Polish dispute over?

Heikes: Over zinc ore. Zinc and lead ore.

Swent: Two adjoining mines.

Heikes: Two adjoining mines fighting each other, stealing ore from each other. They had been doing that for a long time.

Swent: You were able to estimate.

Heikes: They were sloppy as the dickens with their surveying. Management was pretty careless in both companies. When we got in there and did a lot of careful geologic mapping, we found all these things that happened. The precision in the mapping methods that Anaconda developed showed up these discrepancies, which we straightened out. Everybody was happy. The general manager for Hohenlohe and I became very close friends as a result.

Swent: I think you said that somebody from the German Bureau of Mines came and complimented your mapping methods?

Heikes: Oh, yes. There was a book written on ore deposits by Krusch, Beyschlag and Vogt. Krusch was a geologist; I think he was director of the German Geological Survey, and Beyschlag was a professor somewhere, and Vogt was a professor up in Trondheim, in Norway. I got to know all three of them. Krusch visited our mine in Upper Silesia, where we were stationed, and expressed his admiration for our maps and so forth in the Geological Department, which was based on the Butte system.

Mining Coal for Export to Seventeen Countries

Swent: You got into coal mining at one point too.

##

Heikes: Later on, when the Depression got bad in the United States, about 1931, I was asked to go over to the coal mines. We were mining several seams of coal at considerable depth and had about 9,000 men underground, selling three million tons of sized bituminous steam coal to seventeen countries.

Swent: This was also in Poland.

Heikes: All in Poland. My first assignment at the coal mines was to settle their sales complaints, which became a very interesting job. It varied from a bolt eight inches long and an inch and a half in diameter that fell off a bridge or somewhere into a coal car and was subsequently loaded on the railroad and taken up to a gas producing customer up in Northern Poland and wrecked a feeder for a gas producer, to several shiploads of coal shipped to a power plant in Sweden.

Swent: Please tell some more about it. You must have travelled up to Scandinavia.

Heikes: I travelled throughout Scandinavia. It might be of interest to relate one or two incidents. I took a steamship from Gothenburg in Sweden over to Aarhus in northern Denmark and was having lunch with our local coal representative at a hotel in Aarhus when the superintendent of a local manufacturing plant came in to complain about Polish coal. So I was asked, after lunch, to go over and find out what happened at the plant.

Polish Coal and Silica Brick: a Poor Combination in Denmark

Heikes: I went over to this plant which was making cattle feed. They had a large, 800-square-meter furnace, horizontal grid, you know, to burn the coal. The arch of the furnace had stalactites hanging down and the side bricks had melted and were slopped out over and almost covering the grates. It was a horrible mess but the furnace had cooled off enough so I could crawl in there and look at it although it was still pretty hot.

What happened was that the Polish coal has a basic ash and they had been using pure silica brick from Bornholm Island, which was owned by the king of Denmark. The combination of Polish coal with basic ash and this silica brick caused a metallurgical mixture like you would have in a blast furnace, which caused the top and sides of the furnace to melt.

Swent: It was a chemical reaction then.

Heikes: Yes, the chemical affinity of the ash with the brick. They had been using Scotch coal. The Scotch coal had partings of silica sand and the footwall, hanging wall, silica sand, so they matched well with the brick. But the Polish coal ash was entirely a different material and it caused all the trouble.

Swent: So you did yourself out of a customer.

Heikes: I told them that they either get basic brick from Sweden (there was an outfit over there that produced basic brick) or else quit using Polish coal altogether. Anyway, I told them what to do to get the kind of brick that they needed for the kind of coal they were using.

Problems with Polish Coal in Gottland

Heikes: It was interesting. On the island of Gottland out in the Baltic Sea, there was a power plant there supplying half a dozen cement plants. They bought a ship load of Polish steam coal. By the time the coal got to Slite in Gottland, it was half dust. It had been handled so often it was all broken up in fine stuff. When this fine coal got on these furnaces, it all went up in the flue. So the power plant lost its load, which shut down all electric power including cement plants on the island, causing much damage and general confusion.

I settled the matter by sending a shipload of carefully-sized coal that was inspected right up to the last minute and was acceptable.

Improving Conditions in the Mines

Swent: Let's talk a little more about the conditions in Poland. Had the mines been damaged at all by the First World War?

Heikes: The mines had been mined carelessly and extensively to produce the maximum amount of production for the German World War I effort.

The main coal bed had a very thick sandstone hanging wall, and when the coal was mined out irregularly, there were large spots without any support, and the back would come down suddenly acting like a piston pushing through a cylinder. If you happened to be walking in an entryway or mine working, the rush of air would pick you up off your feet and throw you in a ditch or on the floor.

Swent: This is what they call "bump?"

Heikes: That was a bump. They're having bumps all over the world in deep mines where they have hanging wallrock problems.

Swent: How did you deal with that?

Heikes: We mined systematically in the future so that the back would break along long lines. We predicted where the back would break, and we didn't have any more bumps.

Swent: Your job was to try to anticipate where the back would break next.

Heikes: Anticipate the area of the bump ahead of time so it wouldn't happen. That was one problem. The other problem was that they had many mine fires due to air getting into these crushed coal zones causing spontaneous combustion. We had a big quarry plant on the surface where we crushed the coarse rock into fine pieces, mixed it with sand and flushed this all underground in pipes under pressure so we could fill up areas with sand and rock that were mined out. We could take a slice of coal out of an area alongside of a mine fire area and build a barrier in there of sand and gravel so when the fire got there it would stop. We built barriers around our shaft to protect the shafts.

Swent: You did this preventively before there was a fire.

Heikes: We were also trying to keep the coal from getting crushed all the time and getting diluted from soft hanging wall shale in those kind of areas.

Swent: Your last years there, you were mostly working in the coal mines.

Heikes: During the Depression, I was in the coal mining areas much of the time.

Another thing, I had a stepson in the international school in Geneva, Switzerland--Tom Judd.

Marriage to Margaret Chapman Judd

Swent: Yes. Were you married in Poland?

Heikes: No, I was married in New York. Frederick Laist and Reno Sales witnessed for us. We got married in the Old Methodist Church on John Street in New York, in 1930. I had been over in Poland four years. I made a trip home, met and married this lady and took her back to Poland with me. Anaconda had built a house for us and furnished us with a car and chauffeur.

Swent: So you lived well.

Heikes: Yes. I had a good boss. My wife was a darling. She had a master's degree in psychology from the University of California in Los Angeles and knew how to boss me around in good shape.

Swent: What was her name?

Heikes: Ruth Margaret Chapman Heikes. She was a darling. She died of acute leukemia at the Stanford Hospital in 1963.

Swent: She was a widow I think you said.

Heikes: Yes. She was a widow when I married her.

Swent: And had two children?

Heikes: Had two children, a boy, nine, and a girl, eleven. We sent the boy to Princeton and the girl to the University of Wisconsin and they both did very well and have done well all their lives. They've been a pleasure.

Swent: I think you said your son became an ambassador.

Heikes: He reached an ambassador level in the State Department but he never became an ambassador. He was a career diplomat, I guess you would call him.

Swent: They came to live in Poland with you then?

Heikes: Yes, they came over to Poland. We had a little school there in the Anaconda colony. We had a German teacher so the kids learned German; they picked up some Polish as well.

Swent: Was this a school provided by Anaconda?

Heikes: For Anaconda, yes. I taught the girl algebra. By that time I had learned it, so I could teach it. I had been using it a lot in my work.

Swent: There were enough American families there that they had this school.

Heikes: All the men who had taken part in this original evaluation of the mines, mills and smelters stayed on in various executive positions.

Swent: You were there in all, I think you said, nine years?

Heikes: Nine and a half years. I got out and came back before the rest of them. Some of them had to walk westward with the German army coming eastward on their way into Poland.

Foreseeing World War II

Swent: Did you see this coming at all?

Heikes: I saw it way ahead.

Swent: How were you aware of it?

Heikes: It was quite obvious.

Swent: In what way?

Heikes: Well, Hitler came over to Gleiwitz which is a little town in Germany near the Polish border. You could tell that the Poles and the Germans hated each others' guts. All in all, for years and years and years. He made a non-aggression pact with--. Hitler made all kinds of agreements with people and then went right ahead and attacked them anyway. He made a deal with Poland but attacked them when he was ready.

This daughter of my wife, Barbara, was going to school staying with a relative in Washington, D.C., and going to the University of Maryland. She wrote me a letter that she was in love with this football player and intended to get married. I wrote her and said, "Whatever you do, finish up your education, because when a woman marries a man, she doesn't know what's going to happen to her, and you might have to get out and earn a living. You won't be able to do so unless you're properly educated."

She sent a telegram. "No intention of marrying." The Poles got the thing all mixed up, omitted the "no" up in the salutation somewhere. We were at a dinner party and this telegram came in and said, "Intention marrying."

Ruth said, "That's it. We've got to get back to the States and stop this foolishness." So I resigned from Anaconda, packed up all our junk, took Tom out of the International School in Geneva, Switzerland, Ruth went over to France, got a boat and came back to the United States. I followed a couple of weeks later after I got everything settled. The first thing Barbara said was, "I got my money back."

I said, "How was that?"

"On the telegram," she said. "I wasn't going to get married."

We found about that then. I had already resigned so I went into the New York office of Anaconda. "Hello, George. We needed you in Poland but we don't need you over here any more than a dog needs two tails." At that time, Butte was shut down and the geological staff was disseminated and so forth. But they had cut my salary in half although we were making money hand over fist in Poland. I had to change my way of life right quick, which I did.

So here I was, in the United States. Barbara hadn't gotten married; she decided to continue her education like a sensible girl. I had to look for a job. I went down to Washington where George Dern was Secretary of War. He was a close friend of mine.

Swent: He was from Utah.

Heikes: He had been governor of Utah and I had been a friend of the family for a long time. I went to him and applied for a job for strategic materials in case of war--I could see we were going to get into war--a war's targets or air targets or some kind of a job. He didn't have a thing and he was disgusted. I didn't know what had happened to him until a year later, I bought that book Reminiscences of Douglas MacArthur. I found out from that book that about two weeks before I had applied to Mr. Dern for a job that General Douglas MacArthur had been talking with President Roosevelt and insulted him. MacArthur got so mad at the president that he went out on the front porch of the White House and threw up, according to the book. The president said, "You just can't talk to me that way," to MacArthur. They had quite an argument. George Dern, of course, was in the midst of it.

They had cut the armed forces down to practically nothing. There were no jobs of any kind. That's when I asked for a job. I went back up to New York and somebody had gotten into my car, which had been parked in the garage. They stole all my wife's lingerie and my German camera, also cashier's checks. Fortunately I had a gasoline credit card, an old second-hand automobile, and both of us were in good health.

III PROFESSIONAL ACTIVITIES THROUGH WORLD WAR II

Reading Coal and Iron Company, 1935

Heikes: There was a telegram for me at the hotel from my father in Carmel, California. It said, "Andrew Maloney has been trying to get hold of you from Philadelphia Coal and Iron Company. Better get him on the telephone." So I called up Mr. Maloney on the phone. He was president of the Reading Coal and Iron Company.

"How much would it take to get you to come down here and go to work for us?" he says. I gave him a figure. He said, "Come on down. I want you to be assistant to our consulting engineer."

I was broke. I had to post bonds to get these cashier checks reissued. No money. All I had was this credit card to buy gasoline. That was it. I went down there and his secretary says, "I'm Mr. Maloney's brother. He says if you'll stay around until he gets well, he'd like to have you be assistant to his consulting engineer."

I said, "I might as well go over and meet the gentleman now, because I've got nothing else to do."

I went over and met Mr. Louis Gerdetz, consulting engineer. He had been educated in Russia and his first job had been on the Simplon Tunnel in Switzerland. The Simplon is a big railroad tunnel that circled around and up through the Alps. He had been driving tunnels for the Union Pacific Railroad in Oregon and other places, including the Stockton Street Tunnel over to Chinatown in San Francisco. He was trying to cut down on dilution of the Reading anthracite coal mining operations. These were steeply dipping coal beds subject to dilution from weak hanging wall backs.

We got along fine. The only thing was his habits and mine didn't coincide very well. He would come to work about noon. At about five o'clock in the afternoon, he would really get going. I was supposed to come down, open up the office at eight o'clock a.m. and get everybody working, including myself. He would come along all steamed up about time to go home. I would work with him until midnight, we would go out to a night club, get a snack and go home. I was double shifting like that. My wife almost divorced me.

But in the meantime, we both got fired. He went to work for John L. Lewis in Washington, D.C., and I went to work for the Bureau of Mines.

Swent: This was in the late 1930s?

Heikes: Yes, 1936. I had left Poland in 1934.

Works Progress Administration and the Bureau of Mines, 1936-1937

Swent: How did you get the Bureau of Mines job?

Heikes: Dr. Richard J. Lund of the Battelle Institute, Columbus, Ohio, recommended me. We were in the depths of the Depression. The WPA--. You remember the WPA?

Swent: Oh, yes. Works Progress Administration.

Heikes: Works Progress Administration, National Research Project, Department of the Interior, U.S. Bureau of Mines to ascertain job opportunities. I was in charge of non-ferrous mining and started with a book on copper mining.

Swent: You organized the study and were a co-author of a book on copper mining.

Heikes: Oh, yes. Let's see if I can find a copy of it and show it to you. Like everything else, I'm having a difficult time finding anything since the Loma Prieta earthquake when books were thrown from the shelves.

##

Heikes: The idea of the WPA was to have a kind of national research project to see if there were any opportunities in the mining business where they could have reemployment. We were sent around to the different mining companies to obtain a considerable amount of statistical information on man hours and production. We compiled this in relation to the mining methods in use. The outcome showed that there were no opportunities in the mining industry because most of the vein mines were getting depleted and open-pit mining was becoming the thing to do, which didn't employ very many people. There were not many jobs in the non-ferrous activity in the mining business to help employment during the Great Depression.

Swent: Did you inspect mines all over the country?

Heikes: Yes, particularly the lead, zinc, and copper mines.

Swent: Did you visit the mines or did you just compile information that they sent you?

Heikes: I visited the mines too.

Swent: And they sent information in to you.

Heikes: We prepared sketches of mining methods used. That was all published. That's what I wanted to show you. We based the book on man hours per ton so that a geologist could take into consideration the wallrock in the mine and the mineral deposit itself and come up with a mining method. If he could imagine a mining method that would be applicable to this particular ore deposit, he had the man-hour information along with the current labor costs so he could make an estimate of future mining costs in almost any type of underground mine. That was the object of the exercise. It was useful for many purposes later on during World War II.

Swent: But not very useful for getting many jobs.

Heikes: No, it didn't help any. While this work was going on, Tom was going to Princeton and Barbara was going to the University of Wisconsin. I was on a government salary. I was having quite a time when the National Lead Company's Jim Caselton, vice president in charge of mining, contacted me to see if I would go to work for National Lead, which was almost a godsend because I needed the money. I resigned from the government and went to work for National Lead.

Chief Geologist, National Lead Company, 1937-1940

Swent: That was in Missouri?

Heikes: Yes. In 1937.

They had mines in Nevada, Utah, Missouri, Kansas, and California.

Swent: Where was the California mine?

Heikes: The barite property up at El Portal. We were mining barite, which is barium sulfate. The mineral has a very high specific gravity, 4.5. You would grind this up to about 300 mesh, mix it with a little bentonite to keep it in suspension and use the mixture for a drilling mud, it would keep the gas pressure down and lubricate the wallrock of the drill hole during drilling. Barite Corporation, a National Lead subsidiary, was successful and lucrative.

Then I also got mixed up in the titanium activities. Titanium oxide is white, whereas lead oxide is black. Lead carbonate paints would turn black with the sulfur in the air, or turn gray, whereas the titanium pigment paints would stay white. National Lead shifted from lead to titanium in their paints. They kept up with their solder business. National Lead made all kinds of solders and lead products. When National Lead concentrated on titanium pigments, I was sent out looking for titanium deposits.

Later, when I went with Kennecott, they and New Jersey Zinc Company had a big titanium property up in Canada. They were both interested in titanium pigments and metal. Kennecott's interest was in the metal, but this was years later.

Swent: You were chief geologist for National Lead Company.

Heikes: Yes, chief geologist for National Lead Company.

Swent: You were in exploration also.

Heikes: Yes. We were looking for new ore deposits everywhere.

Swent: Did you find any?

Heikes: Yes, but I couldn't sell the company on many of them.

Swent: That's disappointing.

Heikes: Including Carlin area up in Nevada.

Swent: Oh, really? What did you think was there?

Heikes: Gold. Anyway, we had many worthwhile experiences. Tom was graduated from Princeton in International Affairs with very high marks and so was Barbara from Wisconsin in Journalism, so it was quite successful as far as the family was concerned.

Swent: When you worked for National Lead, where were you based? Where were you living?

Heikes: First in St. Louis, later in Salt Lake City

Swent: What made you think there was gold in the Carlin area?

Heikes: There had been some little gold mines around there. A fellow by the name of Roberts, of the Geological Survey, he's the one who actually discovered these very low-grade gold deposits. I didn't know anything about them. I was interested in some high-grade gold that they had on the surface. I didn't know anything about this, this thing that turned out to be such a wonderful bonanza that Newmont got into. How about Malozemoff; did you finish his oral history already?

Swent: Yes, last year.

Heikes: Then you learned a lot about that.

Swent: Some, yes. You were looking not only for lead, then.

Heikes: Anything we could make money at. But I couldn't talk them into even doing any prospecting there. It's just as well; we didn't have enough brains in the outfit to handle that problem.

Swent: Were you working around Utah also?

Heikes: Oh, yes. Utah and Nevada. All over the country. I had a couple of scouts out. They would dig up various propositions and I would go out and look at them and try to sell the company on them if I was interested. The company wasn't much interested in doing very much except sitting on its hands at that time.

Swent: Well, it was a hard time.

Heikes: I guess it was.

Swent: Then the war came along.

Heikes: Yes. I mapped the Pioche mining district where we had an excellent lead-zinc operating property. I was just finishing up the seventh map of seven maps--the report had seven maps in it--I was finishing up the seventh copy of the seventh map when the phone rang. It was C.K. Leith back in Washington. C.K. Leith was the president's adviser on metals and minerals. He said, "We want you back here as soon as possible to be assistant to John Church." John Church, who revised Peele's engineering handbook [Mining Engineers' Handbook], he was a graduate of Columbia and was in charge of copper-zinc for the OPM, Office of Production Management.

Since I couldn't get the St. Louis Smelting and Refining Company, a subsidiary of National Lead, interested in doing some of the things I wanted to do, with opportunities I was enthusiastic about, I resigned from National Lead and accepted the job in Washington D.C. My new salary in Washington was $4,000 a year, I think it was.

Office of Production Management, Copper-Zinc Branch, 1941-1942

Swent: Was that when you were working with Evan Just?[1]

Heikes: No, I had met Evan long before that. I met him when I was with National Lead in Joplin, Missouri. He was secretary of the lead-zinc producers association in Joplin. He was raising Angus cattle on a ranch down in Oklahoma. Did he ever tell you about that?

Swent: Yes, I think he did mention that.

Heikes: Did he? He was one of the strongest men physically I ever met. He was fantastic, a wonderful fellow.

Swent: So you were working near each other in Missouri then.

Heikes: Yes. He has been a friend for a long, long, long time.

Swent: What about Sam Arentz?

Heikes: Oh, I knew Sam a long time too. I don't know when I first met Sam. Long, long ago.

Swent: Then you went back to Washington for the OPM.

Heikes: Yes, I went back to Washington at the OPM as assistant chief of the copper-zinc branch. Later, they separated copper and zinc and formed a zinc branch. They had a fellow by the name of Uebelacker as head of the zinc branch to start with. But he was with Ford, Bacon, and Davis, a consulting engineering firm. They assigned Uebelacker to something else and gave me a whack at zinc. I was able to organize the zinc division from scratch.

Swent: This is the War Production Board.

Heikes: Yes. It was still OPM when I was employed.

---

[1] Evan Just, Geologist: Engineering and Mining Journal, Marshall Plan, Cyprus Mines Corporation, and Stanford University, 1922-1980, Regional Oral History Office, University of California, Berkeley, 1990.

War Production Board, Zinc Division, 1942-1944

Swent: Then it became WPB.

Heikes: They kept changing names. I had a lot of weird experiences in that job. I organized the zinc division from the beginning and I had only experienced men in there. The only regular government employees I had were secretaries and clerks. All the technical employees were thoroughly experienced.

Swent: Mining people.

Heikes: Yes. I had an excellent team. Walter C. Page, James Douglas, Myron Trilsch, Kenneth Cochran, Desdemona Beeson and others.

Saving the Calumet and Arizona Mine

Swent: Were you working with Jim Boyd at all?[1]

Heikes: Jim was with the army and had to do with priorities. In the Calumet and Arizona Mine, in Bisbee, Arizona, a subsidiary of Phelps Dodge, there was the huge Saginaw fault. Their geologist had projected this fault from an upper level to intersect the 2400 foot level at a certain point. The fault flattened out more than expected between levels so in driving the 2400 level, the fault was contacted sooner than expected. The fault carried a heavy supply of water. The miners had blasted when going off shift which was nearer the fault than expected with the result that water rushed through the broken rock into the mine. The mine manager phoned our office in Washington requesting the priority to purchase needed electric cable, switchgear, mine pumps and accessories for pumping out the heavy flow of water.

His requirements conflicted with some navy orders. In those days, everything was under control of an army-navy priority system. I went to Jim Boyd in the army and asked him for his help. He couldn't do anything to help. The navy wouldn't give in. One of the top executives in WPB under Donald Nelson was Bill McCabe, a dollar-a-year man and president of Scott Paper Company. I told him, "We are at risk of losing about 20,000 tons of copper. We're going to need that copper in the worst way, so we had better help Phelps Dodge control the water in that mine."

---

[1] James Boyd, Minerals and Critical Materials Management: Military and Government Administrator and Mining Executive, 1941-1987, Regional Oral History Office, University of California, Berkeley, 1988.

Mr. McCabe finally obtained permission from the army and navy to give Phelps Dodge $250,000 for whatever they wanted to buy if they would do it within three months. That saved the day for them.

Swent: The people who were controlling these priorities had a lot of power.

Heikes: Yes. They certainly did. It was so confusing that the average company executive could not understand the system.

Swent: The executives of the companies you dealt with?

Heikes: Yes. They would come to Washington, the most frustrated fellows you ever saw in your life. Sometimes I could help them. I had two telegrams on the wall in my office. One of them said, "Where in hell is my priority." I forget who signed that. But the other one, "Zinc or we're zunk," was Illinois Steel Company.

Swent: Those were desperate times. Did you enjoy it?

Heikes: I enjoyed it but we were under terrific pressure. I never saw anything like the pressure. I had two secretaries and three telephones and I had a good staff.

Swent: I think it's about time to stop. Then tomorrow we can get you out to Tacoma.

[Interview 2: August 2, 1991]##

Heikes: David A. Uebelacker, from the consulting engineers firm of Ford, Bacon, & Davis in New York, was the first director of the zinc division. But he was the executive-type engineer. The firm called him back to New York on another assignment and the zinc job was turned over to me.

This broke up the copper-zinc branch to form a separate copper division and a separate zinc division.

Swent: It was your job to get priority rating for equipment for mines?

Heikes: Partly, but the big problem was to get zinc concentrates for the zinc producers. I had a combination job there. Priorities came in later. Cartridge brass is 70 percent pure copper and 30 percent pure zinc.

Swent: That is, for weapons.

Heikes: The alloy is 70/30. It has to be that so that the cartridge casing would shrink up quickly enough so that you can eject the cartridge from the gun. The metals had to be very pure, like electrolytic copper and electrolytic zinc. So we had a difficult time getting enough metal for the 30-caliber and 50-caliber ammunition which was used in machine guns. At that time, Senator Truman was investigating everything he could investigate and he had heard a rumor that fighting in the European theater was held up because of a lack of cartridge brass, which was due to a lack of zinc.

So he sent one of his assistants down to my office to investigate why there was a shortage of zinc. The man came in and sat down in a chair, lit up a cigar and after a while I said, "Anything I can do for you, sir?"

He said, "Have you canvassed all the prospectors?"

I said, "No."

"Why haven't you?"

I said, "Why should I? They don't produce anything. Now and then, they find a mineralized area and try to get a grubstake to get some financial help to develop the prospect, but they don't produce any metals."

Then I had to explain some fundamental aspects of the mining business to him. He didn't know anything about mineral resources.

Like most of the men in Congress, he didn't know anything about where metals come from for our USA industry.

Swent: Did you educate him a little bit?

Heikes: I tried to convince him that there was enough zinc to carry on our part of the war and he went back to his office. Part of my duties were to answer inquiries from congressmen and senators. I asked the director of the Geological Survey, Dr. Mendenhall, who was a friend of mine, "What do you do with these congressmen and senators on the Hill?"

Well, he said, "Answer their inquiries as quickly as possible because they have to write to their constituents. That's the trick, promptness. Answer them right away. Give them some kind of an answer so they can answer their constituents." So I did, after that, and got along better as a result.

Aiding Arabian Gold Mining

Swent: Were you pressured at all by more congressmen? You did mention the Calumet and Arizona Mine. Were there any other incidents where mines pressured you to get supplies or equipment?

Heikes: Not particularly, except we received a request for some machinery for a gold mine in Saudi Arabia.

King Ibn Saud owned a gold mine. The American Smelting and Refining Company that was helping him sent one of their employees, a Mr. Twitchell, to my office to get some mine equipment priorities for this gold mine in Saudi Arabia. He said it would benefit the U.S.A. because there was a lot of oil over there.

Based on this request from the American Smelting and Refining Company, I wrote a memorandum to President Roosevelt, sending it through Donald Nelson and channels, recommending that on account of the oil resources over there, we should grant permission for the small amount of mining machinery requested to be sent over to Saudi Arabia. The result was that they made Mr. Twitchell an agricultural emissary, or something like that and sent him over to Saudi Arabia.

Swent: What sort of equipment did they want?

Heikes: Mostly mining equipment. Drills. It didn't amount to much.

Swent: That's interesting because, at that time, the gold mines here in this country were being shut down. What about other American mines that you were able to get supplies for?

Heikes: Yes, gold mines were having a hard time. In order to keep some of the mines in Colorado going--.

Swent: Gold?

Heikes: Yes, mines producing lead and zinc with some gold and silver in the ore. The mines with complex ore got help. The pure producers of gold were closed down, such as in Cripple Creek.

Swent: I thought the War Production Board had closed all the gold mines.

Heikes: The Golden Cycle Mill in Colorado Springs was persuaded to convert part of its gold milling plant to install selective flotation units to treat lead-zinc ores.

Swent: Frank McQuiston was involved in that, wasn't he?

Heikes: Yes, he was. They converted part of their big milling plant to treat lead-zinc ore. We encouraged increasing production at many small lead-zinc properties in Colorado.

Swent: What about your experience, then, with Tacoma Aluminum? You went out there.

Heikes: I left the zinc division to take the job in Tacoma. I needed some experience in aluminum production. Stillman Elfred was vice president with Fred Olin, Olin Corporation, Western Cartridge, and U.S. Cartridge, in East Alton, Illinois. They also owned the Winchester Arms in New Haven, Connecticut. They were the main manufacturers of 30- and 50-caliber ammunition at that time.

Swent: They were the ones who were buying some of the high-grade zinc.

Heikes: Yes. Yesterday we talked about some of the people who were in the zinc division, after I got into the zinc division. James Douglas. He succeeded me when I went out to Tacoma with the Olin Company. And Myron Trilsch. Walter C. Page, who was my deputy. He became vice president of U.S. Smelting and Refining Company a short time later.

Swent: These people were all trained in mining or metallurgy?

Heikes: They were all expert mining engineers, yes. Except Trilsch. Trilsch was a good bureaucrat. He wrote letters. You get, almost like junk mail, so many inquiries. Somebody's got to answer all these letters. It could easily drive a man crazy if he's trying to accomplish something and also taking care of all the letters and paperwork.

Swent: That was in the day of manual typewriters and carbon paper.

Heikes: Yes. Trilsch took care of all that detail for me so I didn't have to bother with it, because it was driving me nuts. I detest it anyway.

Swent: Did you do most of your work in Washington, or did you go out?

Heikes: Well, I had been in most of the mines, mills and smelters. I was pretty familiar with all the copper, lead, and zinc mines in the United States by that time. So I didn't have to visit them. But I held meetings in Washington with the presidents of all the various companies and then chaired the meetings, even with the CIO present. The AFL-CIO was present at some of these meetings, a fellow named Robinson. Louis Cates for Phelps Dodge and Stannard of Kennecott and Dwyer with Anaconda and well, New Jersey Zinc Company. And Howard Young. He was president of American Zinc Lead & Smelting Company.

Swent: That is a pretty impressive list.

Heikes: Ben Zimmer was president of the American Metal Company.

Swent: You were making very impressive contacts, then, weren't you?

Heikes: Yes. I had the cream of the crop there all the time.

Swent: And those were tense times.

Olin Company, Tacoma Aluminum, 1943-1944

Swent: What about your experience then with Tacoma Aluminum?

Heikes: The Olin Company spent a considerable sum of money trying to develop a method to treat clays and alunite ore from a Utah mine to recover the alumina. The company was called Kalunite, with a plant near Salt Lake City, Utah. This is a letter from Stillman Elfred to me when I was director of the zinc division.

Eventually, when I left the War Production Board and went to Tacoma and took the job as manager of their alumina plant, I had had enough training in electrometallurgy and electrical engineering so that I was quite at home in that plant.

KALUNITE, INC.

EAST ALTON . . . . ILLINOIS

December 24, 1942

Mr. Geo. C. Heikes
4700 Locust Hill Court
Begesda, Maryland

Dear George:

Thanks for your telephone call yesterday evening and may I reciprocate your Good Wishes for 1943.

I want to give you some confidential information regarding our aluminum situation in order that you can be guided in your decisions in reference to our several conversations on this subject.

Kalunite, Inc. has spent a very large sum of money developing an acid process to produce alumina from alunite ores, producing as a by-product approximately one-half ton of potassium sulphate for each ton of alumina.

The pilot plant resumed operation in Salt Lake City in 1937 under the management of Dr. Arthur Fleischer with Mr. Frank Eichelberger, President of Kalunite, Inc., directing the work. The results were most promising and indicate that Kalunite can produce alumina competitively with the Bayer Process by crediting the by-product at the muriate price. You appreciate that the muriate is quoted $10.00 plus below the sulphate price.

When the war intensified the requirement of aluminum it was essential to increase production rapidly and the War Production Board certified an exceptionally large sum to the Aluminum Company to accomplish the result. After investigating the Kalunite, Inc. Process they received commending reports:

> On April 17th, 1941 the Bureau of Mines wrote a very comprehensive report approving the Process and recommending a 1,000 ton plant. This was not accepted as final by the War Production Board and the National Academy of Science was injected into the picture. The conservative seasoned men on this committee recommended that

the War Production Board authorize the smallest tonnage unit utilizing standard equipment. This was decided by the Academy as being one hundred and sixty seven tons of ore per day, however has since been increased to five hundred tons of ore per day. The present indications are that it will be substantially increased when we produce the first month's alumina of a satisfactory quality.

You can hear many opinions, guess, etc., both for and against the production of alumina from alunite. We cannot guarantee any results but all of our pilot plant operations indicate that it will be successful. Like all new processes the present practice refuses to acknowledge the possibilities.

We are now operating the pilot plant on high aluminous clays to determine if the tremendous tonnage of this natural resource will give up the alumina in quality and quantity to be considered a commercial possibility.

At this writing all the "bugs" are not eliminated, however the staff at Salt Lake feels confident that we will be able to compete with alumina produced from clays. This is a most important development and one can forecast great future possibilities if it becomes a reality.

The War Production Board is advancing the funds for the clay work, with all development and patents being the property of Kalunite, Inc. with "shop rights" to the Government.

At the time the Defense Plant Corporation authorized the Kalunite plant, they also certified the Olin Corporation to manage an aluminum reduction plant at Tacoma, Washington. This plant was financed by the Defense Plant Corporation and is the property of the United States Government.

The reduction unit is operated upon a fee from the Government and the contract expires in 1948. The contract can be canceled at the end of three years. We constructed a forty million pound aluminum plant using the Soderberg electrode. We have two pot rooms of 120 pots to each room, operating on 32,000 amperes. At this writing one pot room is in complete production making a very satisfactory grade of aluminum and is producing in excess of rated capacity.

The construction and starting of this plant is under the consulting ability of Mr. A. Sjoli, a citizen of Norway who has engineered and placed in production more than thirty aluminum reduction plants. Mr. Sjoli will not be a permanent member of our staff at Tacoma, but will educate the Tacoma organization concerning the operation of an aluminum reduction plant. He is ably assisted by his son.

In our original aluminum organization plan we had one management over both Salt Lake City, Utah and Tacoma, Washington. Because of the difference in the requirement of each unit and the distance between the two plants, we decided in November, 1942 to operate under two separate managements, one at Salt Lake City and the other at Tacoma, with both units reporting direct to East Alton.

In November, 1942 we employed Mr. R. E. Phelan as General Manager of Kalunite, Inc. Mr. Phelan was the original manager of the Hudson Bay Mining and Smelting Corporation. Mr. M. M. Moser who had been acting as General Manager of both units was requested to confine his activities to Olin Corporation at Tacoma, Washington. Mr. Moser is a man of ability, however his past experience was mostly confined to coal mining and it is my judgment that he prefers to be connected with a mine. He is handicapped in an electrolytic reduction unit and may find it difficult to adjust himself to the new environment.

With this confidential information, it is my thought to recommend to the Board of Directors of the Olin Corporation that we change our organization at Tacoma and install a Plant Manager who will be delegated to represent the Company with full authority. He should qualify as the business management and operating management. The individual must have foresight in planning and positiveness in execution because he will be several thousand miles away from the executive office. Although the executive office is always willing to assist, there are many prompt decisions that cannot be referred to East Alton and I might add should not be referred to East Alton. Until I am reasonably assured that I have such a man in view I cannot make my positive assertions to the Board of Directors.

The Government will authorize up to $12,000 annually on this position and I would be more than satisfied to have the privilege of recommending you to the Board of Directors of Olin Corporation and request certification from the Defense Plant Corporation for the maximum of $12,000 annually.

What does the future hold? I wish I had the ability to answer my own question. If we are to remain in the aluminum picture it will be because we have organized a staff that can accomplish desired results. They must merit the confidence of the Olin Corporation Board of Directors. I think that I can assure you that the Olin Corporation will build an aluminum industry whenever the staff can justify their recommendations to the Board, therefore our aluminum picture depends upon those connected directly with the operations. I know that Tacoma is starting satisfactorily and I know you would be an asset to the operation.

Looking forward to talking to you at home on Tuesday, December 29th, I am

Sincerely,

Stillman Elfred

F.S. Elfred/il

The former Tacoma plant manager wasn't doing very well so they sent me out there to replace him. I had the job of firing him when I took charge.

Swent: That's not easy.

Heikes: That wasn't very nice either, but he wanted to get back to coal mining, which was his experience.

Swent: Were you able to get the plant turned around?

Heikes: I should say so. That's a very interesting subject. My predecessor engaged the services of some very competent young engineers. They were excellent electrical and mechanical engineers. I held a meeting, after I became manager, and asked each one of these men what he wanted to do. They had been wanting to do all kinds of things, but my predecessor wouldn't let them, because he couldn't understand what it was all about, I suppose. I let them go ahead.

Within a fortnight, that plant was operating very efficiently, due to the efforts of these young men who were finally turned loose on what they wanted to do.

Swent: Were you managing just the reduction plant?

Heikes: Yes. Until we were able to treat the alumina produced at our plant in Salt Lake we purchased the raw material from the Aluminum Company of America.

Swent: Where did that come from?

Heikes: Mostly Arkansas. The process of successfully treating alunite ore from a mine in southern Utah was still in research. In the meantime we were producing about 40,000 tons of ingot aluminum yearly.

Arthur Bunker was made chief of staff of the War Production Board. Arthur had been director of the aluminum-magnesium division while I was director of the zinc division. We got to be very good friends. When he was made chief of staff, I wrote to him and congratulated him. He wrote me this letter.

Swent: Oh, very nice. [reads letter] May I take this and make a copy also?

Heikes: Yes, if you want.

Swent: It's interesting that they didn't take someone from the aluminum division to do this.

38a

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

WAR PRODUCTION BOARD
WASHINGTON, D. C.

8 January 1944

IN REPLY REFER TO:

Dear George,

Thank you so much for your letter of congratulations on my new white man's burden. To put it frankly, I do not envy myself. You know quite well what three years of slavery has meant in this place and I embark upon my new ventures with somewhat less strength of heart than the man who walked in here naively in the middle of 1941.

I hear very good things of you. We have no designs on your plant, and while shots may fall around you, I do not believe that they will strike you. I saw Stilly at dinner last night and had a most pleasant evening, among other things referring to your most capable efforts in the Northwest.

Sincerely,

A. H. Bunker

George C. Heikes
Resident Manager
Olin Corp., Aluminum Division
3400 Taylor Way
Tacoma 2, Washington

Heikes: Well, they were looking for a manager and I guess they didn't have the manager type they wanted in the aluminum division. Since Elfred figured I could manage anything, that was why they sent me out there. Of course, it was a very peculiar situation, where you had to fire the guy that you replaced.

Swent: I think you said you had some dealings with Jim Richardson at that time?

Heikes: That was later when the plant was going. He said he would take-- across the United States--. He said, "Your plant's the most unsafe plant. They get worse as you get out West, and you're the worst." And so forth and so forth. We got that all straightened out in a jiffy.

Swent: Had it been unsafe?

Heikes: Not particularly. It was just his opinion. We were using a different process than the Aluminum Company of America was. We were using the Soderberg, a Norwegian process, where you put in the anode cake and let it harden up over the furnace. We were lucky to have a Norwegian specialist from his company educate us in using the Soderberg technique. I joined in learning with the rest of my staff.

I was helped in all directions. I had Mr. Sjoli, the Norwegian engineer, and his son, who were Soderberg experts, and I had all these other young enthusiastic engineers who were very good in their field. All I had to do was keep them busy.

War Production Board, Aluminum-Magnesium Division, 1944-1945

Swent: After you got that organized all right and going, then you went back to Washington.

Heikes: Mr. Arthur Bunker wanted me to come back to Washington when he was promoted to chief of staff of WPB. He wanted me to take over the aluminum-magnesium division that he had built up.

Swent: With WPB again.

Heikes: Yes. And take over his former division.

I had another reason to go to Washington. My wife's son Tom was a captain in the army air force and had been shot down over Yugoslavia. The army had sent back all of his effects saying he had been killed in action. We didn't accept that. I said, "He's not dead; he's around somewhere." My wife was in touch with the Red Cross and she wanted to get back to Washington where she could get more information about Tom. This fit in very well with what Bunker wanted me to do.

So I went back and headed up the aluminum-magnesium division. The experience that I had at that aluminum plant, plus what I knew about bauxite mines and alumina production all fit together.

##

Heikes: He was flying a P-38, that fighter airplane had twin motors and a tail piece. The tail piece hit him when he was forced to bail out. When he had one engine on fire, the other engine was missing, he was only about a thousand feet above the ground, so he bailed out. He cut his head. When they got him, they bandaged that up and paraded him around through the streets of Sofia, Bulgaria. Then the enemy put him in a prison camp in the northeast corner of Bulgaria. There is a lot of history to that too. Maybe we'll get into that.

Later, when I was in Greece, I had a friend tell me the story about getting these prisoners out of Bulgaria, down to the Turkish border and later getting them over to Brindisi in Italy to recuperate.

Swent: He was one of them.

Heikes: He was one of them. But anyway, he came home eventually.

Swent: But there was a long time there when you didn't know.

Heikes: We went back to Washington. We bought a house out in Locust Hills in Bethesda, near the Navy Hospital. I guess it's worth a king's ransom now because we had a couple of acres of ground and a beautiful three-story home.

Shutting Down Aluminum and Magnesium Plants

Heikes: I went to work with the aluminum-magnesium division of WPB. My job was shutting down plants, whereas Arthur Bunker had been building them up. The government had too much aluminum, too much magnesium. I had to shut down Basic Magnesium out in Las Vegas and I had to shut down big aluminum plants up in the state of Washington and back East and convert them into warehouses. We used silver in busbars to save copper. We returned the silver to the Treasury.

Swent: Silver what?

Heikes: Silver busbars to carry the electric current. Aluminum requires a very high amperage and a low voltage. We couldn't spare the copper, so they used silver. Silver is a very good conductor of electricity, so they installed silver busbars. A busbar was about three or four inches wide and about one half-inch thick [demonstrates] made out of pure silver.

We used silver busbars in the place of copper. The Treasury had a lot of silver in those days. I don't know what they did with it, if they still have it or what. Anyway, we turned it back to them.

I got into one congressional investigation after another so I was up on the Hill week after week, answering questions regarding shutting down plants. In these investigations, you sit there like a fish in a bowl and they're picking at you.

Swent: What were they investigating?

Heikes: Investigating why we had to shut down their plants, put all these people out of work and so forth.

Swent: Did you do this on your own initiative or were you told to shut them down?

Heikes: We were producing too much metal and the government didn't need it.

Swent: Who decided that you did or did not need it?

Heikes: The Army-Navy Munitions Board and the War Production Board.

Swent: But they had been financed by the government, hadn't they?

Heikes: Most of them. In any case, I had to develop a technique. I got tired of attending congressional investigations. I developed a technique. If I had to shut down a plant, I called up the senior senator in that area and told him that we were going to have to shut down a plant in his area and that I would like to come to his office to talk to him and explain to him why.

That's what I did. I went up and talked to each one of these senators. Sometimes, I took somebody with me. Most of the time, I went alone, to explain what we were going to have to do and find out the best way to do it, so I wouldn't disrupt his community any more than absolutely necessary. So instead of the headlines coming out on the front page, the news came out as a small article way back somewhere in the newspaper. That was a great help.

Swent: Did you just unilaterally, independently, make the decision to shut the plant down?

Heikes: No, I didn't make the decision. It was a combined decision of the War Production Board. My staff provided the basic information. The decision would go all the way up to the top. Cap Krug was then in charge of WPB. I've got a letter from him too.

Willard Dow, president of Dow Chemical Company, had criticized the War Production Board for some reason or other in connection with magnesium production. I got him on the telephone and I asked him, the next time he was in Washington, if he would stop in and then we could talk the thing over. He came down right away. He had a Lockheed Lodestar and flew down to Washington. We straightened out the difficulties.

Swent: What was the difficulty?

Heikes: I forget the detail now. Subsequently, he offered me a job as vice president of Dow Chemical Company, but I didn't think that a man who had been in my position in Washington should take a job like that. I thanked him for it but I didn't take it. I had been admiring Thayer Lindsley for years as one of the greatest ore finders they ever had in Canada. I wanted to find out why he was so successful. So I met Lindsley. I resigned from the War Production Board, aluminum-magnesium division of WPB, and went to work for Lindsley in Toronto.

Swent: Is that when Krug wrote you this letter?

Heikes: Yes. That's a farewell letter from the War Production Board.

Swent: Maybe we should just read it, and then we'll have it on the tape. Do you want to read it? Then we'll get it on the tape.

Heikes: Do you want me to read it?

Swent: Please, because we can't photograph it because it's framed.

Heikes: This is a letter from J. A. Krug, who was chairman of the War Production Board, dated April 4, 1945.

"Dear George,

I cannot let the occasion of your resignation from the War Production Board pass without expressing my gratitude and that of the entire board for your outstanding part in the war effort. You have made a major contribution in two of the most vital materials of metals and mineral production. As chief of the zinc division and in other key positions in connection with zinc from early 1941 until middle 1943, you were largely responsible for the peak production attained by zinc at a time when our needs for that metal were at that most critical point.

Aluminum also reached its highest wartime production rate after you generously returned to the board in the summer of 1944 to head the aluminum-magnesium division, which you guided through a period rendered particularly difficult by great variations in military requirements.

Your success in promoting good relations between the division and the public, particularly with labor groups, is also noteworthy. You carry with you into private life my best personal wishes.

Sincerely,

J. A. Krug, Chairman"

Swent: That's a wonderful letter. He signed it just "Cap." Peak production attained by zinc.

Heikes: Yes. Here was Chief Irving Wilson, the chairman of the board of Aluminum Company of America. I had quite a few dealings with Mr. Wilson and with his boss, Arthur Vining Davis, of the Aluminum Company of America.

Swent: There were lots of very prestigious people there.

IV POST-WORLD WAR II ACTIVITIES

Vice President, Mines, Inc., Subsidiary of Ventures, Limited, Toronto, 1945-1948

Swent: So then you went to Canada.

Heikes: I went to Canada and became an assistant to Thayer Lindsley, president of Ventures, Ltd., for a few years. Lindsley formed an American subsidiary called Mines, Inc., and made me vice president in charge of it, with an office in New York City.

Swent: And Zellidja? Why don't you tell about that?

Heikes: Zellidja, yes. That's an interesting story.

Zellidja Lead Mine

Heikes: When I was vice president of Mines, Inc., a subsidiary of Ventures, Ltd., I had an assistant, Enzo de Chetelat, who knew Jean Walter's son at the Ecole [Nationale Superieure] des Mines in Paris. Mr. Walter had acquired the Zellidja Mine for his son and built a small town at the mine.

Jean Walter owned Zellidja. Walter was the architect who designed the Peace Palace in Geneva. Walter was a very rich man and a successful architect. St. Joe Lead Company, at that time Francis Cameron was chairman, and Ventures, Ltd., was interested in acquiring Zellidja. Fred Searls, who was president of Newmont--.

Let's talk for a minute. Mrs. Walter and Mrs. Anthony Biddle were sitting next to each other in a lady's hair place in Paris. Mrs. Biddle says--(she was on the board of directors of Newmont--), "I'm going back over to New York." They were both under those drying things.

Mrs. Walter said, "I'm going over to New York with my husband to sell his Zellidja property to Ventures Limited."

Mrs. Biddle spoke up. "Don't bother with them," she said, "Newmont is the greatest mining company in the United States. You should consider the Newmont Company. They are a lot better equipped and a lot better financed than Ventures."

So Mr. and Mrs. Walter came over to the United States. Fred Searls, president of Newmont at the time, wanted to entertain them. I met them at the boat and took them up to the Waldorf and got a suite there. Jimmy Gerard--did you ever hear of Jimmy Gerard? He was United States Ambassador to Germany during World War I, when old Kaiser Wilhelm I was in charge. Gerard had married Marcus Daley's daughter and he was worth a couple hundred million dollars. He had a nice home across from the Metropolitan Art Museum on Fifth Avenue in New York. He was a very close friend of mine. He arranged for a dinner for Mr. and Mrs. Walter, Thayer Lindsley, Mrs. Heikes and me at his home. A butler standing at the back of each chair, of course, a very formal dinner. Mrs. Walter had a big emerald. I was sitting next to Mr. Gerard. He said, "Look at that. As big as a biscuit." [laughter]

Anyway, Newmont and St. Joe Lead and Ventures purchased this Zellidja property. Later, when Mines, Inc., got hard up, we sold our interest to St. Joe and Newmont. When we were unable to get money from Canada for Mines, Inc., we had to stop operations. I was vice president in charge at the time so I folded up Mines, Inc., and went with Kennecott Copper Company.[1]

I don't know what happened after that with Zellidja. John Gustafson was sent over to examine the property for Newmont. I think he recommended it. Then Gustafson later became vice president of M. A. Hanna Company. I did consulting work for him for about three years there while he was with M. A. Hanna Company. By that time, I had hung out my shingle as a mining geologist consultant.

We're jumping around something fierce here.

Swent: No, no. We're just going right along.

Heikes: My job with Ventures was a very interesting, because they had a lot of dealings with the Canadian government. I represented Ventures on some of the problems. Ventures had twenty-one mining subsidiaries at that time.

Swent: Were you going out and actually inspecting the mining properties?

---

[1] For more information on Zellidja, see Frank Woods McQuiston, Jr., Metallurgist for Newmont Mining Corporation and U.S. Atomic Energy Commission, 1934-1982, Regional Oral History Office, University of California, Berkeley, 1989.

Heikes: Oh, no, no. I was dealing directly with several Canadian government units trying to get money for our overseas interests. I didn't go out in the field at all in Canada. We tied up some mercury properties in Italy for one thing.

Swent: Did you develop the mercury mines?

Heikes: We ran out of money. We had cash funds in Falconbridge and the Foreign Exchange Control Board wouldn't let us take any money out of Canada. So we had to sell our interest in Zellidja to St. Joe Lead and Newmont Mining Company. I went and borrowed a quarter of a million dollars from Guaranty Trust Company using Giant Yellowknife stock as collateral, folded up Mines, Inc., and got a job with Kennecott.

Kennecott Copper Company, 1948-1949

Swent: How did that go? Did you like that?

Heikes: Kennecott?

Swent: Yes.

Heikes: No, I didn't like it at all. I had a big office on the same floor with the executives, and was made executive assistant to the vice president in charge of exploration, Mr. Anton Gray. I was living in Scarsdale, New York at that time and commuting to New York. I would get up early in the morning, walk to the Scarsdale Station and take a New York Central train to Grand Central Station, get on the subway to lower Broadway. Our office was at 120 Broadway, 37th floor. I had a beautiful big office, as big as this living room, overlooking the harbor.

I had a very capable secretary, Mary Frances Tynan. She had been the secretary to the president of New Jersey Zinc and later became secretary to Millikan, president of Kennecott. I guess she stayed with Kennecott most of her life.

Bob Atkinson, a young mining engineer in the office, took care of the correspondence, and I got out into the field as much as possible. At that time, Kennecott was interested in the gold mines in South Africa. Atkinson became a vice president of Kennecott.

Anton Gray, who as I said was the vice president in charge of exploration, was spending a lot of his time in Africa.

Swent: Where?

Heikes: Johannesburg. In connection with the gold mining, in connection with the Orange Reef there. I didn't have anything to do with that, didn't know anything about it. Anyway, I got tired of the commuting rat race, getting up before daylight in order to get to the office by about eight o'clock and then catch a train at five o'clock to go home.

Swent: Were you conducting any explorations?

Heikes: Oh, yes, a lot. All over the world. Many of them up in Canada. I was looking after many things, as I remember. I was quite busy.

Swent: But most of the time you were in New York.

Heikes: Yes. I was in New York with Ventures and then with Kennecott. I guess I was in New York about six or seven years.

Economic Cooperation Administration (Marshall Plan), Greece, 1949-1950

Swent: How did the opportunity to go to Greece come about?

Heikes: Well, Charles Will Wright, mineral specialist for the State Department, and the diplomat in charge of the Greek desk in the State Department, wanted to get a mining geologist to go over to Greece--Greece had been pretty badly damaged by the war and subsequently by its civil war--and see if it was possible to get a mining business in operation. They wanted me to leave Kennecott and go over to Greece, which I did.

The Greek experience developed into one of the best experiences I ever had in my life.

Well, let's go back a little bit. When I got over to Greece, I was put in charge of mining with the objective to encourage as much employment in the mining business as possible. Mine plants had been destroyed.

Swent: The ECA.

Heikes: The Economic Cooperation Administration.

Swent: This is what we usually call the Marshall Plan, isn't it.

Heikes: Yes, the Marshall Plan was just beginning at that time.

##

Swent: So you were head of the mining division of the Marshall Plan in Greece. What did they mine in Greece? Of course, they had ancient gold mines.

Heikes: They sure did. Did you know that?

Swent: Well, yes. I had read of Jason and the golden fleece.

Heikes: That gold came from Northern Macedonia.

Swent: Right. And coal mines?

Heikes: They were importing bituminous coal from other European countries, as they had only lignite in Greece.

When I got over to Greece, there was no such thing as a Geological Survey. There was a Bureau of Mines which was mostly involved in helping the customs officials evaluate the mining machinery being imported.

There has been considerable volcanic activity in Greece so it was logical to have a vulcanologist/geologist. Mr. Liatsikas, vulcanologist had made a detailed study of the island of Santorini, a volcanic island. About 3,000 or 4,000 years ago, most of this island was destroyed by the volcano blowing up, leaving a crescent-shaped remnant and revealing a cross section of pumice, scoria, different shades of black, brown, and gray. Then in recent times, a new volcanic cone built up where the old one had been. The ancient volcanic explosion had formed tsunami or great sea waves that inundated the island of Crete to the south, causing many deaths and considerable damage.

My first sight of this beautiful island was from a small Greek steamship as it approached the island. It was just about dawn and the huge cliffs with the whitewashed stone buildings on top of the cliffs, the town of Thera, were quite a sight.

Swent: It must have been a beautiful sight.

Heikes: It was a beautiful sight. Thera. It's a gorgeous island.

Organizing a Geological Survey in Greece

Swent: You said there had been no geological survey in Greece.

Heikes: No. So we recruited a number of men with a geologic education, organized a geological survey, and put vulcanologist Liatsakis in charge. Then we hired some senior geologists from other countries in Europe to come to Greece and work with these Greek geologists. There were quite a few of them. Petraschek, from Leoben Mining Academy in Austria, and Liatsakis went on a field trip. It started to rain and the Greek driver was too optimistic. The British had paved these highways with a fine tar finish on the surface instead of a rough finish. Where the farm wagons had come onto the highway, bringing mud, it made the highway slick and slippery. The driver didn't slow down the jeep he was driving and they hit one of these slick spots where mud had been brought up from the fields. The jeep spun around, went into a ditch, killed Liatsakis, and put Petraschek in the hospital for a couple of months.

I selected Liatsakis' successor, a competent mining geologist, Kiriakos Zakos--he happened to have been on the staff there, a young geologist--because he appeared to have considerable executive ability and a sound training. He became director of the newly formed geological survey.

Swent: Were the geologists there as well trained as American geologists?

Heikes: Yes, they had been trained in Austria, Germany, and France.

We had a German and we had a Hungarian.

Swent: Were they well trained?

Heikes: Yes, very well. For example, Deloczy had been director of the Hungarian Geological Survey for many years but left. We had a German who later became the director of the German Geological Survey in West Germany. They were all very high-powered experts. We got the cream of the crop because at that time, things were pretty rough in Europe. We were able to pick up some very unusual talent at a reasonable price and get them to come down to Greece, which they all loved to do anyway. The Germans always look forward to coming to Greece in the winter time, if they could possibly do it. So we had no trouble in hiring personnel to come down there and help us. There were a couple of young fellows in the group that were already pretty good at reading German and French and any other language that geology might be written in.

We obtained a general staff topographic 1:500,000 scale map of Greece and put on it all the geology we could obtain from existing literature. Then we formed field parties to check the geology literature and map the blank areas, correcting and adding new information, and finally built up a pretty good geologic map of Greece. The original is now on file at the Geological Department of the San Jose State University. Director Zakos wrote on this original map, "We all did our part but without Heikes, we never would have gotten this done." Anyway, it was a fine map. Now we had a base for mining problems. Mines that had been closed were refinanced and put into operation along with several new properties, such as bauxite and lignite.

Swent: This was in 1949 and 1950.

Heikes: Yes. During the preparation of the geological map of Greece. We noted in our survey the following: the gold-bearing placers; the famous silver-bearing lead-zinc mines at Laurium, thirty-five miles southeast of Athens, that were the source of wealth to build the Parthenon on the Acropolis and to build the fleet of warships to protect Greece; a small battery-grade manganese mine; lateritic iron ore containing nickel (garnerite); many deposits of fine marble including the Penteli quarry near Kifissia, the source of marble for the Parthenon; bauxite, then being shipped to England to make quick-setting cement for concrete work under salt water; lignite, an early form of coal used for heating; magnesite, for furnace linings, on the island of Euboea; and barite, from the island of Milos. It was apparent that the diaspore bauxite and lignite occurred in sufficient amounts to justify a thorough investigation. In recent times, oil and gas were found in the Aegean Sea between Greece and Turkey.

From a historical point of view, the Gallico River placer gold deposits of Macedonia in northern Greece had been an early source of gold for Alexander the Great. On the river, there was a Yuba Dredge that had been purchased in recent years by a Greek mining company.

When we first went to Greece, we lived in a hotel in Kiffisia near the Penteli Quarry, the source of marble for many buildings in Athens and the Parthenon on the Acropolis. Sometime later, I rented a house in Ecali, about eighteen miles north of Athens. It had its own water supply wells, central heating, and oil furnaces, and was constructed of marble and had been built by the great guerilla fighter, the famous General Zerva. That mansion had the finest, most elegant barroom in all of Greece. I wasn't drinking or smoking so I didn't enjoy it as much as I might have.

Swent: It must have been very pleasant living though.

Heikes: Yes, it was. The climate in Greece is gorgeous, it's just marvelous. Like San Jose, here. Dry hot days and cool nights.

Greek Bauxite Mining: Arranging a Deal with the German Aluminum Industry

Swent: Can you tell more about it?

Heikes: Greece had large reserves of diaspore, a clay with high aluminum content that can be used for the production of alumina, from which aluminum metal is recovered using an electrolytic process. In the early days of the Marshall Plan, the U.S. government supplied the dollars to purchase American-made equipment. For example, if a Greek mining company wished to purchase a large bulldozer, they would put the equivalent value in Greek drachma into a trust fund in the Bank of Greece, these drachma to be used for some worthwhile project, and the U.S.A. would supply the U.S. dollars. At that time, the U.S.A. was interested in accumulating aluminum metal in its stockpile. About twenty million dollars worth of drachma had been accumulated in the Bank of Greece. If it turned out to be feasible to do so, we planned on developing the diaspore, bauxite mining properties, buying the ore with drachma, shipping the bauxite in Greek ships to Germany. I went to Germany and obtained the cooperation of the German aluminum industry to use Greek diaspore. Shortly thereafter we shipped diaspore to Germany, paid for producing alumina from diaspore with diaspore and paid for reducing the alumina to aluminum ingots with diaspore and ending up with a sizable stockpile of aluminum ingots for our stockpile of strategic materials.

Getting Lignite Coal into Production for Electricity in Greece

Heikes: Greece had been importing bituminous coal from Europe for many years. When I was in Poland from 1926 to 1934, Polish mines were selling bituminous steam coal to Greece for railroads and heating. When I got to Greece, I found out they had millions of tons of low-grade coal called lignite. The Greeks were mining lignite underground at Aliverion on the island of Euboea but at Ptolemais there was a tremendous deposit of lignite near the surface. An open-cast mining operation was started there. A steam power plant was erected using lignite and a briquetting plant was installed to prepare the lignite for railroad use. Getting the old and new bauxite mines into operation and the open-cast lignite mine into production were major contributions to the welfare of Greece.

The Bank of Greece loaned money to Greek mining companies to undertake these new projects, with the U.S.A. furnishing the U.S. dollar where needed.

Defense Materials Procurement Agency, Region IV, London, 1951

Heikes: In 1951, the ECA transferred me to London. A short time later, the Defense Materials Procurement Agency [DMPA] was formed. London was the headquarters for Region IV, all of Africa and Europe. I was placed in charge of mine development. The DMPA would loan money to mining companies in return for metal to be produced to build up our stockpile of strategic materials during the Korean War.

That was also an interesting job. The only trouble was, I didn't get out in the field. I had to stay in the office all the time in London, but I had very capable engineers and geologists on my staff, including John Vanderburg, MacPherson, and Enzo de Chetelat.

Swent: What were some of the mines you developed?

Heikes: In Africa, we had contracts with Selections Trust, with Ronald Prain amongst others.

Swent: There were things in the Congo?

Heikes: Yes, a lot of work there--cobalt and copper properties. I made several trips to Brussels, Belgium, to arrange agreements with the Union Miniere Company.

Swent: Was this a successful program, you think?

Heikes: Yes, everything went as planned in this project. The loans were paid back; the metal was delivered. Evan Just was one of my bosses with DMPA in Washington at the time.

General Thomas Bayne Wilson was in charge of Region IV. He was an experienced railroad man and had been vice-president of Southern Pacific in charge of operations. During World War II he was in charge of transportation in India. He had had a lot of good experience and was a competent leader. James Douglas, the brother of Lewis Douglas, then the ambassador to Great Britain, was his assistant.

Swent: They were from the Arizona mining family.

Heikes: Yes. Jim Douglas had succeeded me as head of the zinc division when I went and took the job with the Olin Company to manage their aluminum plant in Tacoma, Washington, in 1944.

Swent: Then did he work with you again in London?

Heikes: Yes, we worked together in London 1950 to 1953. He was assistant to General Wilson.

Swent: It must have been a pleasant time though.

Heikes: Yes, it was a very good experience. I had an office right over the main entrance of the American embassy in Grosvenor Square. The flag was hanging out under my window. I liked that job.

I had been a member of the Cosmos Club in Washington for many years and when I went over to London, the Cosmos Club had reciprocal arrangements with the Saville Club, which was around the corner from the U.S. embassy. I went over there one day at lunch time. "Well, we're glad to see you, Mr. Heikes. Make yourself right at home. We're having a luncheon up on the second floor. Just go up there, sit anywhere you want and make yourself comfortable." So I did. There was a big round table and I went up and sat down at this round table. Pretty soon, a big burly fellow came and sat down next to me. He asked me, "Are you a spiv?" I said, "What's a spiv?" He said, "One who gets along in this world without any visible means of support and this table is reserved for spivs." He turned out to be an American who could talk with a British accent.

I had dealings with the top men in the mining industry in Britain who had offices in London at that time.

Swent: You spent a few years as an independent consultant.

Heikes: When I came back to the United States in 1953, I bought a house in Los Altos and hung out my shingle as a mining geologist.

Ralph M. Parsons Company, Los Angeles, California, 1953

Swent: Then you went with Parsons.

Heikes: I was asked to examine a property for a group of men including Mr. Ralph M. Parsons. I examined the property for them with the result that Ray Jenkins, vice president, asked me to join the mining division of the Parsons Company in Los Angeles.

About that same time, the Cyprus Mines Company of Los Angeles engaged the Parsons Company to prepare plans for an open-pit lead-zinc surface mine and mill in the Yukon. Cyprus turned over to Parsons the results of their intensive diamond drilling program at their Anvil property. My first job with Parsons was to study the drill logs and assays, and prepare a plan for an open pit mine.

##

Swent: Was it a gold mine?

Heikes: No, it was a complex lead-zinc orebody containing some silver and gold.

Swent: Was it a place you could get to? Was it easy to get to or hard to get to?

Heikes: It was hard to get to. Two hundred and fifty miles northeasterly from Whitehorse.

Swent: Can you do an open-pit operation up there?

Heikes: They did, and then the Parsons Company built a mill for them.

Swent: And it was successful?

Heikes: Yes, quite successful.

Swent: Did you go up there?

Heikes: No, I didn't go to the mine. I did the office work in the Parsons office in Los Angeles on the basis of the information supplied by Cyprus Mining Company.

"Operation Hardrock," Surveying the Mineral Resources of India, 1967-1971

Swent: How did you get into the Indian project?

Heikes: While I was working on the Anvil project in Los Angeles, the Parsons Company was invited to bid on an airborne mineral survey in certain selected areas of India where local Indian geologists believed there might be commercial deposits of copper, lead and zinc.

Josiah Royce, a graduate geologist from Harvard, was in the U.S. embassy in New Delhi and with Desh Sikka from the Geological Survey of India proposed an airborne survey of certain parts of India where some commercial mineral deposits of copper, lead, and zinc might exist and thereby save India a considerable amount of foreign exchange instead of buying the metals on world markets.

Bids were requested from different companies. Parsons Company won the bid. Parsons then asked me if I would go to India as their project manager. That's how I got mixed up in it. Parson selected fifteen employees including me. Most of them were married and had grown-up children. The government of India selected 110 geologists and geophysicists from the Geological Survey of India to join the staff, and supplied many supporting drivers and drillers.

A camp, with its many tents, looked like Charlemagne's army on a campaign, because the Indian personnel had their wives and children with them in the field. The project had nine wireline diamond drills, eleven vehicles, and two field laboratories in addition to a big central chemical laboratory near New Delhi. The project cost 3.5 million U.S. dollars and about 8 million dollars equivalent in Indian rupees.

While I was in India, my first chief geologist was Jack F.B. Sillman and later on H.R. Cooke; both had received their doctorate degrees in geology at Harvard. They were excellent geologists and leaders. Sillman is now in Lightning Ridge, Australia, and has been very successful mining opals in his own mine. Cooke is retired and living on the island of Tenerife in the Canary Islands off the west coast of Africa.

When we had the 7.1 Richter Scale earthquake here in California, at Loma Prieta, Sillman telephoned me from Australia and Cooke telephoned me from the Canary Islands to see if Mrs. Heikes and I were all right.

Swent: That was very kind of them. So how did you do your survey? Tell me more about the survey.

Heikes: Here is a copy of an article by Dr. A.P. Subramaniam describing Operation Hardrock presented at the 24th International Geological Congress held in Canada in 1972. He was deputy general director of the Geological Survey of India and my counterpart directing the project.[2]

---

[2] The article is included in the appendix to this volume.

Aerial Mineral Survey

Heikes: The Indian Army supplied the aerial photographs. These were cut up and trimmed, matched and pasted on cardboard to form a mosaic on which were placed the flight lines for the aerial survey. As a plane flew at low altitude over the projected flight line a 35mm movie camera recorded the flight. When a road, railroad, or river was flown over, an operator pressed a button to record the spot on the photograph film and on the Honeywell recorder. This was to adjust for head winds or tail winds and to show the exact location of an anomaly. The geophysical instruments were synchronized with the Honeywell recorder. At the close of each flying day the 35mm film was developed and compared to the flight line and the record on the recorder. Over 11,000 anomalies were thus indicated, each of them to be subsequently investigated by field crews on the ground.

Swent: You told me that you used navy planes.

Heikes: Yes, we did. We had two PBYs, each with a heavy load of instruments and operators.

Swent: Why did you use those?

Heikes: They had extra wide wing spread, big engines to lift the plane from the water and could carry a heavy load close to the ground. Parsons engaged Aeroservices of Philadelphia to do the flying. They flew over the areas the Indian government wanted us to explore. This was mostly in Rajasthan, the desert west of New Delhi; Andhra Pradesh, a state in Southern India; and Bihar, West Bengal, near Calcutta, in the eastern part of India.

Very good geologists were in charge of each of these field parties. This is a picture here of one of the camps. Here is a group sitting around the table discussing the day's events. This man's name is B. Srikantan. This is his wife and daughter.

Swent: It looks awfully hot and dry.

Heikes: At first my counterpart was Dr. K. Jacobs. Later on, Dr. A.P. Subramaniam was placed in charge. Dr. Subramaniam had obtained his doctor's degree in geology at Princeton.

I can't find my report, but I at least have this. This article by Subramaniam here describes the project.

Swent: It says the project covered four years; were you there four years?

Heikes: Yes.

Swent: From 1967 to 1971.

Heikes: Here's a historical record of Project Hardrock. I guess we'll come out here where we can spread this out, Mrs. Swent. This here shows the highlights of each of the reports I received from the field and all other important events.

Swent: That's a mammoth document.

Heikes: These are the things that happened during the project, some of the ore that we found. This showed the Aeroservice of Philadelphia fliers. This shows what each airplane did, each day. The personnel, when they came to work, their names. This one here shows the Indian personnel and their names. This drawing shows a complete record of the whole project.

Swent: So you were coordinating diamond drilling and surface and air reports.

Heikes: Yes. It took a long time before we got around to a project that was worth diamond drilling.

Swent: I noticed that it said diamond drilling there, though.

Heikes: Yes, we had nine airline drills, and some of the best drilling men you can think of. Only lost one man on that whole project, and that was a driller, an Indian apprentice. He left his tent one night to go out and relieve himself and got stung by a viper. His boss had taken the jeep and gone to get supplies so there was no transportation for him to get to a doctor. He died before they could get help for him.

Swent: Isn't that tragic.

Heikes: But that's the only one. Of all the airplanes and land vehicles, some of which rolled over, but that driller was the only casualty we had on the project.

Swent: This document must be ten feet long and three feet wide at least.

Heikes: It shows everything that happened and when it happened.

Swent: A marvelous document.

Heikes: I worked on this every night.

Swent: You did this all by hand.

Heikes: Instead of getting drunk and disorderly to relax myself, I relaxed myself on this thing.

Swent: That's a fantastic document, with tiny, tiny little writing and perfectly legible. Beautiful writing and covered with detail of all kinds, every month.

Heikes: It's a fine record to have. This one here, this shows what the airplanes did. I just kept this for my own records but the Indian government insisted on having it included in the final report.

Swent: That was a wonderful project.

Heikes: It was an interesting project too.

Swent: You must have enjoyed that. Did your wife go out with you then?

Heikes: Yes, she was there, taking good care of me all the time. My first wife, after thirty-one years, got acute leukemia very suddenly. She was rushed to Letterman Hospital in San Francisco, where they diagnosed acute leukemia. We got her to Stanford Hospital near her daughter and she died there within two months. I went back to Korea to finish up my tour there.

Swent: We haven't mentioned the Korean tour yet.

Heikes: I didn't mention Korea?

Swent: We kind of skipped that. USOM, what's that?

Heikes: United States Operational Mission, Korea, Agency for International Cooperation.

Swent: I see. This was in 1960-1964.

Heikes: Yes. She died in 1963, and I went back to Korea to finish up my tour as chief of mining in Korea. Anyway, the U.S. government wanted me to go to Korea and do what I had done in Greece. After Ruth died, I met this young lady [my present wife]. This is a very remarkable, unusual young lady. I can tell you that. She started a business making sweaters. She's all for high quality production. She had some German and British knitting machines. She hired these young girls just coming out of the farms and so forth. They would make sweaters and she would arrange that they do so much work and then have the rest of the time off. That's the way she got production out of them.

Then the Korean War started. When the armies would come in, they would bury these knitting machines and run for the hills and wait until the armies went the other way and then come back and dig them up and go back to work. Finally, she got tired of directing people, quit the business and started buying houses and hiring contractors to fix them up and then living in them for a while and selling them and buying another house somewhere, an old-beat up house. She would then fix it up real nice, live in it for a while and sell it. She had built up quite a business when I met her. I guess we should have done the same thing here in the U.S.A. but we didn't. We've got one house about a block away that is rented.

Well, anyway, Operation Hardrock was a very fine project. I liked India. It was a very fine experience.

Swent: You said that you thought that Parsons was a good company to work for.

Heikes: Excellent, excellent.

Swent: From India, you went over to Australia then.

Heikes: When this project was finished, I went back to Los Angeles, wrote the report, two volumes over an inch thick and 8 1/2 by 11. We sent fifty copies over to India.

Partnerships Pacific, Australia, 1971-1973

Heikes: Then Parsons wanted me to go to Australia. In Australia, there was a group called Partnerships Pacific comprising Bank of America, Bank of New South Wales, and Bank of Tokyo that had formed a partnership and, amongst other activities, were loaning money to mining companies.

Swent: This was in 1971.

Heikes: Now and then, I was supposed to decide whether they should or should not loan the money. Some politicians had shares of stock in this or that property. For example, there was an antimony gold property in the northwest part of Australia. The owners wanted to build an antimony smelter. I had had considerable experience with a similar situation in Nevada and would not recommend a smelter until they had found enough ore to justify the $12 million Australian dollar investment. I was in the doghouse on account of that. I was unpopular most of the time because I was extra careful.

Anyway, we survived it all.

Swent: You certainly did.

Heikes: Then we came back here to this house. I had rented it for nine years while we were gone.

Agency for International Development, Korea, 1960-1964

[Interview 3: August 10, 1991]##

Swent: Today we wanted to talk about your work in Korea. You went there in 1960 with something called USOM.

Heikes: United States Operations Mission. Part of the U.S. Agency for International Development. I had succeeded pretty well in Greece, so they wanted me to go over to Korea.

Swent: In Greece, I think you were working with funds from both Greece and the United States, weren't you?

Heikes: In Greece, whenever a Greek company wanted to buy a bulldozer, the company would put up the money in drachma. The drachma would go in a special fund in the Bank of Greece and the United States would buy the bulldozer, supplying the U.S. dollars. The accumulated drachma would be used for worthwhile projects in Greece.

Swent: Was there a credit already there because of loans we had made during the war?

Heikes: I don't know. The war had pretty well exhausted Greece. The communist guerrillas destroyed what was left after World War II, mine buildings were torn down and railroad tracks were destroyed. In many cases the shafts were caved in as well as tunnel portals.

Swent: Was there a comparable situation in Korea?

Heikes: No. Korea was still recovering from the Korean War and the U.S. was trying to make available to them the means to get their mining industry back on its feet, making as much employment as was possible and as much self-support as possible.

Swent: Were you there by invitation? Did they want you there?

Heikes: Oh, yes. They begged me to go over there and I quit a very good job to do it.

Swent: But were the Koreans welcoming to the Americans?

Heikes: They did welcome Americans. In Korea they were mining anthracite coal from veins rather than flat-lying beds. These were nearly vertical lenticular veins of coal that had been subjected to tremendous heat and pressure to make hard low volatile anthracite coal. The government engaged the services of Pierce Management, a consulting engineering company from Scranton, Pennsylvania, to improve the existing coal mines.

Swent: Was the coal similar to what you find around Scranton?

Heikes: Both were low volatile anthracite. This consulting company was a world consulting group. The local manager in Korea was John J. L. G. Weysser. He was a graduate of Lehigh, same school I went to, and had had considerable experience.

Swent: Was he over there with you?

Heikes: Yes. I was in charge of the Pierce Management contract.

Swent: You were in charge of the whole operation.

Heikes: I was in charge of the mining division of the U.S. Operations Mission.

Swent: Who did you report to?

Heikes: The local chief of the U.S. Operations Mission. USOM engaged Pierce Management to work on the coal mines and Utah Construction to work on the tungsten refining plant, various geological investigations and diamond drilling.

Swent: Who represented Utah over there? Who was Utah's chief over there?

Heikes: Earl O. Torgerson. He now lives in Mountain View [California]. He was in charge of constructing a tungsten chemical plant for the Korean Tungsten Company and had charge of the other Utah contracts.

Increasing Production in the Coal Mines

Swent: Were you reviving something that had been there before?

Heikes: Yes. The anthracite mines had been there for many years. Pierce Management improved operations and increased production.

Swent: How did they do that?

Heikes: By mechanizing parts of the mines that could be mechanized. In Korea, briquettes with anthracite coal of different sizes were an important fuel for heating and cooking. The briquettes were from six inches in diameter and about eight inches long to twelve inches in diameter and about twelve to fourteen inches long. In each briquette there were a number of holes so the air could come up through and burn the slow-burning anthracite coal. At the side of the old-fashioned Korean house there is usually a stove. Anthracite briquettes are used in these stoves. They burn down to the ash stage and then another fresh briquette is placed on top of the old briquette. They keep hot water on the stove all the time. The flue from the stove goes under the floor to the other side of the house. Old-timer Koreans sit and sleep on the floor warmed by the flue under it. They call these ondol floors.

The old people sleep on the floor over at the hot end of the room, the young people over at the cooler end of the room. Covering this ondol floor is a highly polished fabric of some kind that they keep clean all the time. Bedding is folded up and put in cabinets along the side of the room and taken out when needed. Old-timer Koreans bring in a little low table and sit cross-legged on the floor while they eat.

Swent: That's a very practical system, isn't it?

Heikes: Yes. Then they also have rubber shoes. In the old days, it was quite muddy around. So they would take off these shoes and go in the house and walk around in their socks or stockings to keep the ondol floors clean at all times.

So the anthracite coal industry is very important in the life of Korea. There are also a few power plants run with anthracite coal.

Swent: What about the mining? Are the mines all in one district?

Heikes: Oh, no. The mines are scattered all over the country.

Swent: Were they privately owned or publicly owned?

Heikes: They are owned privately and also by the Dai Han Coal Company, a government company.

Swent: Was it government-owned?

Heikes: That's a government-private corporation--combination. This is from the chairman of the coal company. [presents framed object] They had a big dinner and gave me this memento at the dinner.

Swent: This is a beautiful frame inlaid with abalone shell, with silk tassels for hanging. It's a letter of appreciation. Shall I read it?

Heikes: Yes, would you please?

Swent: "The seventeenth of March, 1964.

Mr. George C. Heikes,

I hereby express my most respect and appreciation for your valuable contribution to the development of the coal mining in the Republic of Korea. During your tenure as the chief of the mining division of the USOM-Korea, or the mineral industries advisor to the Ministry of Commerce and Industry, Republic of Korea, from July, 1960, to February, 1964, your devotion to the task has greatly contributed to the reconstruction of the mining industry in this country. Your sincere assistance rendered to Korea will always be remembered by the coal mining industry and the people of Korea."

It is signed "Paik Yun Heung, Chairman, Dai Han Coal Mining Association, Inc." Then he has signed it and it's also in Korean on the other side of the certificate. That's a beautiful thing.

Heikes: Then in addition to coal, they had the largest tungsten mine in the free world.

Swent: This is a similar certificate.

Heikes: No, this is another one. This is by the minister of Commerce and Industry.

They had tungsten, they had some graphite mining properties (graphite is what is used in lead pencils), some potential copper-lead-zinc mines, and several small mines with iron ore.

Swent: Shall I read this also?

Heikes: Yes, can you read that?

Swent: This says, "Republic of Korea, Ministry of Commerce and Industry, March 13, 1964.
To: Mr. George C. Heikes
Subject: Letter of Appreciation

On behalf of the government and the people of the Republic of Korea, I extend you their most sincere appreciation for your valuable contribution to the development of the mining industry in the Republic of Korea. During your tenure as the chief of the mining division of the USOM-Korea from July, 1960, to November, 1962, and later as the mineral industries advisor to the Ministry of Commerce and Industry from February, 1963, to February, 1964, your devotion to the task has greatly contributed to the programming and implementing of the five-year development plan of the mineral industry. Your kind assistance and encouragement rendered to Korea in a manner of deep friendship will always be remembered by the mining industry and the Korean people."

It is signed, "Lee, Byong Ho, Minister of Commerce and Industry."

Well, that is really lovely.

Making New Geological Maps for Korea

Swent: Now can you fill in the gaps?

Heikes: I concentrated on the Geological Survey.

Swent: Did they already have a geological survey?

Heikes: Yes, they had a good geological survey, under the management of Dr. Kim Ok Joon. He was one of my best friends and was a graduate of the Colorado School of Mines.

Swent: A Korean?

Heikes: A Korean, yes. Kim Ok Joon. Ok is a valuable rock that hasn't been cut yet, so the value is inside of it. [locates address book] Here we are. A professor of geology at Yonsei University now.

Swent: He was the head of the Geological Survey? Did they already have good maps?

Heikes: Their maps were good. The U.S. Army had flown over Korea and had made a new topographic map. I was able to talk the U.S. general in charge into letting the Korean Geological Survey have copies of these maps. The Koreans posted their geology on these new topographic maps and ended up with a very good set of geological maps.

Swent: Did you turn up anything new in this that they didn't have before?

Heikes: Not that I know of but it gave an excellent base for future investigations. I spent most of my time in the Korean Geological Survey office rather than in the USOM office because I believed I was able to accomplish more there.

More About Korean Mines

Swent: What about their mining methods?

Heikes: Mining methods varied according to the ore deposit. As mentioned previously, the anthracite coal deposits were mostly vertical lenticular veins, the exception was the big Sandung tungsten deposit which was a bedded deposit dipping gently to the north underground. There were no open-pit mines other than quarries for marble, graphite, sand and gravel, and raw material, limestone and clay for cement plants.

Swent: What was the state of their mechanization?

Heikes: According to the ore deposits they had, it was about as modern as you could get. They had good drills and compressors and they had good mechanical equipment.

Swent: I understood you to say that one of your jobs was to mechanize their mining.

Heikes: Mechanize them in the coal mines.

Swent: In the coal. I see. The metal mines were already mechanized.

Heikes: As much as they could be.

Swent: So you didn't make any change there?

Heikes: We didn't make any great changes.

Swent: Did they consider safety and health?

Heikes: Oh, yes. Very much so.

Swent: Ventilation was good?

Heikes: Oh, yes.

Swent: Had the mines been disrupted by the war?

Heikes: No. They hadn't been affected by the war, as they had been in Greece. They were completely wrecked over in Greece.

Swent: But here they were not.

Heikes: No. As far as I know, they weren't.

Swent: Their production had continued?

Heikes: Maybe some of the coal mines were damaged but they soon got back into production. Anthracite mines don't catch fire like bituminous coal mines or lignite mines do, so there were no problems with that. There were no problems with rock pressures, bumps and fires or other troubles that happen in mines.

Swent: Well, if everything was all modern and mechanized and wonderful, why did they need you?

Heikes: It wasn't all mechanized and wonderful. It was pretty good considering everything, but we suggested more modern equipment where it was necessary.

Swent: What kind of equipment did you use?

Heikes: Well, drills and mining equipment of various kinds. I don't remember all of what was done.

Swent: This was when the tungsten carbide drill bits were coming in, weren't they?

Heikes: Yes, we used detachable bits there too.

Swent: Was labor cheap?

Heikes: It wasn't cheap but you might want to compare it. Compared with the United States it was cheap, but about the highest wages paid in the country were in the mining industry. You can put it that way. I can't tell you right off hand what they amounted to.

Swent: Were the workman skilled?

Heikes: The workman were wonderful. Good miners. Excellent miners.

Swent: Well trained?

Heikes: They were all pretty well trained.

Swent: Do they have a Korean school of mines?

Heikes: Oh, yes. They had several schools of mines. Seoul National University had a mining division, the main mining school in the country as far as I remember. But they had many lower mining schools, like high schools or vocational schools, where people learned how to mine. Then there were many on-the-job training opportunities. They took a farmer boy and trained him from the very beginning.

Swent: Did they manufacture equipment there?

Heikes: No, they bought most of the equipment they needed from abroad.

Swent: Do you recall what kind?

Heikes: They bought it from most anywhere they could get what they wanted at a reasonable price, some of it from the United States, some of it from other countries.

Swent: Scandinavia and Europe were beginning to manufacture more.

Heikes: Koreans didn't get anything from Scandinavia, that I remember. Most of it came from the United States.

Swent: Gardner-Denver? EIMCO?

Heikes: Yes. Purchases were scattered around pretty well. Pierce Management was doing that. I didn't follow it very closely.

Swent: I see.

Heikes: In fact, I did not get involved directly because Pierce Management was taking care of that whole anthracite mining situation and Utah Construction on other matters, particularly diamond drilling. I don't know as many details as I might have as I didn't interfere with contractors working. I got underground a few times to check on this and that but by and large, I stayed away from them. As I said, I spent more time with the Geological Survey and geological problems because a greater contribution could be made in that activity. There were some very competent American mining engineers on the job with Pierce Management and Utah Construction Company who had more experience than I did in the operating phase of the mining business.

Swent: Had did you feel about the job in general?

Heikes: The contractors did an excellent job. Pierce Management and Utah Construction Company.

Getting Along with the Bureaucracy

Swent: Did you get involved in bureaucratic red tape at all?

Heikes: Yes, a little locally in Korea with USOM colleagues.

Swent: You were a long way from Washington.

Heikes: Yes. Things went very smoothly with Washington headquarters.

Swent: You had to deal with the Korean government.

Heikes: Everything went smoothly with the Korean government.

Swent: What kind of troubles did you have?

Heikes: An overstaffed bureaucratic USOM in Seoul that had been there a long time before I got there.

When I first went to Korea in 1960 a Mr. Moyer was in charge. He had built up a large staff that was comfortably housed in the 8th Army compound, had nice houses to live in, a bus to take them to work in the morning and bring them home in the evening.

I didn't go along with some of the ideas of my colleagues. For example, they wanted to send Koreans over to study the U.S. mining law. The mining law of 1872 in the United States was designed to open up the vast areas of unexplored territory and was not applicable to countries where real estate was sold by the square foot and mineral land belonging to the government was subjected to a careful and tight leasing system. Over here, our law of 1872 allowed anybody to stake a claim on a mineral showing. The main object was to encourage development of the vast areas of undeveloped land.

Swent: Did they study mining methods as well as mining law?

Heikes: I don't know. The mining laws in the U.S.A., Canada and Australia were to encourage an individual without great wealth to stake a claim on a mineral showing and start building up from scratch, if he could find financial help go get started.

Swent: That was what the mining law was designed for.

Heikes: That was what it was designed for. It helped build up the country.

##

Heikes: About 1962 Mr. Moyer was replaced by Mr. Killian as director of USOM. Mr. Killian sent home about two thirds of the personnel in USOM as an economy move.

Swent: Kennedy became president in 1960. Was it the change of administration that led to the improvement?

Heikes: Oh, no. I don't think Kennedy knew anything about it. I think it had to do with the State Department.

One of the difficult things in foreign countries was for people to understand the Marshall Plan. They couldn't understand why any nation would go in and spend a lot of money trying to help other people as they did in Greece.

Swent: Why did your job come to an end there?

Heikes: You would be surprised. After my first wife died--. I had been married thirty-one years to a very charming lady. She got acute leukemia while in Korea. The U.S. government sent her home, first to Letterman Hospital in the Presidio in San Francisco, then I transferred her to Stanford, where she could be near her daughter Barbara. She died in the Stanford Hospital. I went back to Korea to finish my tour.

Swent: Did you have a contract for a certain term?

Heikes: Yes. A four-year term. I went back to Korea, met a capable Korean lady about a year later and married her.

Marriage to Myung Ja Yu

Swent: You had mentioned that the other day.

Heikes: Before the Korean War, she bought some knitting machines, British and German, and started a factory in Seoul making sweaters, insisting on quality. Because she said, "If people are going to spend their money, which is very hard to come by, they had better get something worthwhile to show for it."

In order to get production at her sweater factory, she would give her employees a certain amount of work to do each day. When they finished that, they could go home.

The Korean War came in while she was running this factory. When an army would come in, her employees would bury the knitting machines, run for the hills, come back later and dig them up and go back to work again. Finally she got tired of working with people and started buying old beat-up houses, hiring contractors to fix them up. Then she would move in for a while, sell the house and buy another one, hire contractors to fix it up, and so forth.

Swent: Where was she doing this?

Heikes: In Seoul. When I married her, she had three houses in Seoul and one in Taegu. She has been a very remarkable wife. We've been married twenty-eight years so far.

Swent: What is her name?

Heikes: Yu Myung Ja. Myung Ja Heikes now. We were married by the mayor of Seoul. I came into the USOM office afterward and said, "I just got married."

They said, "You what? Don't you realize you're the most highly classified man around here and you shouldn't get married to a local without permission?"

I said, "Why does an old guy my age have to get permission to get married? What am I supposed to do now?"

"You gotta resign."

I said, "All right. I resign."

"Now, slow down, slow down." They sent a telegram to Washington and said, "In view of Heikes' excellent record with the agency, we desire that you waive the regulation concerning marrying a local."

They wired back and they said, "We can't change our regulations but we'll agree to pay her way back to the States."

So in July of 1964, I think it was, we came back to the States. We bought this house January 25, 1965.

Swent: Did you get back into mining then, too?

Heikes: Right away. I started consulting.

Swent: That's when you went to work for Parsons.

Heikes: A job came up. A local vice president of U.S. Steel Corporation and Ralph M. Parsons had become interested in a copper prospect in Nevada. They asked me to make an examination of it for them. As a result of that, I was asked by Ray Jenkins, vice president of mining for the Ralph M. Parsons Company in Los Angeles, to join their staff. Later on, Parsons sent me to India and later Australia.

More About Examination of Mining Properties in Australia

Swent: We had talked about the India work, but you had not talked much about Australia.

Heikes: My work in Australia consisted of a series of mine examinations, one after another. As I said, many of them were related to Partnerships Pacific which was a consortium of Bank of America, Bank of Tokyo, and Bank of New South Wales. Amongst others they were loaning money to mining companies and I was asked in some cases whether they should or should not make a loan. Usually if the loan was backed up with salable real estate and the ore deposit was not well defined, as was the case with several placer deposits of sapphires, the loan was based on the value of the real estate.. In cases where the loan was based on diamond or rotary drilling results great care had to be taken.

Swent: What were some of the properties you looked at? Where were they?

Heikes: Well, the one that gave me the most trouble was an antimony-gold property in Nullagine, Western Australia. Owners wanted $12 million for a smelter. The diamond drilling results submitted were not sufficient to justify the loan.

Swent: Did anything result from some of the ones that you recommended?

Heikes: No. There were not any large mineral properties under investigation at that time.

Swent: Did you find anything exiting?

Heikes: No, nothing exciting. A short time before I left Australia a client of the Parsons Company was offered a copper prospect on the eastern part of the island of Timor in Indonesia. I was sent there to examine the property which was small and apparently lacking a potential for further investigation. Turned it down. On April 1, 1973, we returned to the U.S.A. and obtained some consulting work with Continental Materials on the gold bearing copper property they had diamond drilled near Oracle, in the mountains north of Tucson, Arizona.

Oracle Ridge, Arizona

Heikes: Continental Materials Corporation of Chicago, Illinois, acquired a large area containing veins with gold- and silver-bearing copper sulfides in the mountains near Oracle, northerly from Tucson, Arizona. Roads had been bulldozed to provide access by diamond drilling crews and a considerable amount of money had been spent on diamond drilling and drill-core analysis. I was on the property from April, 1973, until January 27, 1975, preparing many cross-sections as well as a glass see-through model of one of the orebodies. We returned to our home in San Jose, California, on January 29, 1975.

Subsequently, Union Miniere of Belgium became interested in the Oracle Ridge copper project, did considerable additional drilling, but did not acquire the property.

In the April 1991 issue of Southwestern Pay Dirt published in Bisbee, Arizona, there was an interesting article describing the most recent work on Oracle Ridge.[1]

Swent: [Reads] "Southwestern Pay Dirt is a publication serving the mining industry in Arizona, New Mexico, and Southern California." The article says, "Oracle Ridge: New Arizona Copper Producer is On Line." This is from the April, 1991 issue.

Heikes: I came back to San Jose long before this property was put into operation.

Swent: "South Atlantic Ventures brings new mill on line to produce 900,000 tons of copper and 1540 ounces of gold this year (1991)."

Heikes: When I left Arizona, Continental was still drilling.

Swent: South Atlantic Ventures, Limited, of Vancouver.

Heikes: That's a new outfit to me.

Swent: And Continental Materials Corporation of Chicago.

Heikes: I worked for Continental.

Swent: They were partners in Oracle Ridge.

Heikes: In fact, Gerald Gidwitz, chairman of the board of the Helene Curtis Cosmetics in Chicago--. He started out making mud. First, he started out making mud for the ladies. Mud on their face there and shrink up their face and then they would wash it off and it would make them feel better. He started on that years ago and then got into this cosmetics business.

---

[1] Copy of the article is attached.

Then came the uranium boon, and he wanted to try mining. Being a very lucky fellow, he struck some very rich mines and they made a lot of money for him.

Swent: Where were they?

Heikes: On the Colorado plateau, in Utah, mostly in Utah. His vice president in charge of all these mining ventures flew his own plane. In coming up from Arizona to Utah, he got into a very bad storm. He and his passengers were all killed. Then, about that time, he wanted to go public with his ventures, to make a public stock, for which he needed some reports. So in one way or another, I was recommended to Van Alstyne, Knoll & Company, a brokerage firm in New York. I examined all these properties for Van Alstyne, Knoll & Company--property belonging to Continental Uranium.

Swent: Was that Gidwitz's company?

Heikes: Continental Uranium was Gidwitz. After Bob Prues, the vice president, died in his airplane accident, Mr. Gidwitz asked me to come to work for them, which I did. They made me manager of mineral resources. I enjoyed working for them for several years. Then the Agency for International Development in Washington, D.C., contacted me to see if I would go over to Korea. That's how I got mixed up with Korea.

Dilution of Ore; a Fundamental Problem in Some Mineral Resource Projects

Swent: Did you want to say anything more about the problem of dilution? You said that this has always been the fundamental problem.

Heikes: Yes, it is a fundamental problem in mining. Most mines have problems with dilution. We didn't have any problem with dilution in Korea, nor in Australia; I wasn't mixed up in any operating mines there.

Swent: Why is it such a problem?

Heikes: Why is it a problem? Well, with the Reading Coal and Iron for example, they were selling eight and a half million tons of anthracite coal a year on the East Coast. Very carefully sized because in many cases the coal would have to be carried a bucketful at a time up three or four flights of stairs without any elevator. Then they would have to carry the ashes back out again. The coal had to be carefully sized and bright and shiny.

Well, when that was mined--for example, when I went to work for Reading Coal and Iron Company, they had fifteen collieries in operation. They hoisted fifteen million tons of rock and coal, of which they sold eight and a half million tons. The problem was to cut down on this waste. If stopes were too wide and the rock in the back was weak, stopes could be made narrower.

The company invested in large washing and screening plants to get rid of the waste rock, polish the coal and make it pretty, and size it for the various markets.

Anthracite coal was a very expensive commodity for heating. I used in the house I had in Washington, D.C.

Swent: I think you said that this had been a problem at Butte also.

Heikes: In Butte, it was a serious economic problem. Shift bosses were praised on the amount of tons per shift, rather than the pounds of metal per shift. So if you were able to increase the metal content in each ton of ore hoisted or raise the grade, you were able to make more money. That was my job, to try to increase the grade of ore by mapping the stopes and cutting down on mining and shipping waste. It didn't make that much difference later on when they had a mill. But when I was there, they were shipping ore directly to the smelter at Anaconda and that made a big difference in the economics of the operation. Later on, when they had a mill in Butte, they were shipping lower grade ore to the mill and getting rid of the waste rock that way.

Swent: But you said that this wasn't a problem in Korea.

Heikes: We didn't have any dilution problems in mining in Korea that I knew about. The miners mining anthracite coal didn't mine waste along with coal.

Swent: And you weren't really involved with the tungsten mines.

Heikes: No, the tungsten mine was well managed, had a good mill also and they were mining a good grade of ore. It was a very thick deposit, generally flat lying and dipping to the north gently. More like a soft coal mine than a tungsten mine. They had different layers of grade of tungsten ore. They had to be careful of course but I don't remember any dilution problems there, as one had in the United States anthracite and bituminous coal mines.

Swent: Another thing that you had mentioned when we were talking was the copper water that was a problem.

Heikes: Yes. That was a quite a problem for the miners in Butte. Many of them were working in places where copper water was dripping from the back. They would get copper water on them and some of them with very sensitive skins would get little sores from the copper sulfate on their skin. At the end of the shift after a shower, the miners would rub their sores with zinc oxide ointment

Swent: Copper sulfate is actually an acid.

Heikes: Yes. Copper sulfate is a very strong acid. I didn't ever have any trouble. My skin was pretty tough, I guess, and I wasn't exposed to it long enough to do any harm. I was only subject to copper water for a short time before I was moved into some other activity that was less hazardous. They moved me around a lot, to get experience which I deeply appreciated.

Swent: Good experience.

Heikes: A lot of experience.

Swent: And you've put it all to good use, haven't you?

Heikes: I was very lucky all the way through.

Swent: You've certainly had a lot of interesting jobs. I think maybe we've just about covered everything, don't you?

Heikes: I think that about covers the picture. After I left the Parsons Company in Australia and came back to the States, Continental Materials asked in help on the Oracle Ridge project. I did what I could there and then came home. Since I've been here, I haven't done any consulting or anything else.

Ethics and Mining Stock Sales

Heikes: Trying to keep people out of trouble was my main occupation. There are a lot of promoters trying to get people to buy cheap stock in phony mines.

Swent: They are still around, are they?

Heikes: Oh, there are still a lot of them around. You would be surprised. I've steered clear of those kinds of projects all my life, where one was selling stocks to the public. It's the best way to make money in the mining business. If you can sell a lot of cheap stock for a mine promotion.

Swent: Some people are gullible.

Heikes: Millions of greedy people who want to get something for nothing. They want a cheap stock that will make them a lot of money right quick. To get mixed up in a thing like that is bad business for a consultant. I might have missed some good opportunities to make money.

Anyway, when I resigned from the War Production Board, I went to work in Toronto for Thayer Lindsley, president of Ventures, Ltd., and a very able mining man.

##

Swent: This is a book called Free Gold: The Story of Canadian Mining, by Arnold Hoffman. It's inscribed to George Heikes, with compliments of the author, June 23, 1947. Arnold Hoffman. Was he a friend of yours?

Heikes: Yes, he was, and his brother Robert, who died December 5, 1975.

I went to work in 1945 for Thayer Lindsley, Ventures, Ltd., Toronto, Canada. Thayer Lindsley was one of the most amazing men I ever knew. Here are some of the mines that he developed right here on page 134 of Free Gold.

Swent: Oh, my. A long list of them. Falconbridge among them.

Heikes: I knew many of these men in this book. I got to know Jowsey pretty well. This might interest you. I don't know whether you should have the machine on or not but let me give you an idea of how these things work. Do you want to turn that off or leave it on.

Swent: It's all right; we'll leave it on.

Heikes: Thayer Lindsley would form a company, say with three million shares. When a prospector would submit a prospect, Thayer would agree to give him, for example, 300,000 to 500,000 shares for the prospect if the preliminary examination was of interest. A geologist would be sent out to examine the property. If the geologist reported favorably, Thayer would sell 300,000 shares to his close friends in Toronto to get risk money, say at ten cents per share, to get $30,000. This money would be used for more detailed investigation such as geochemical and geophysical research, trenching, bulldozing the surface, preliminary drilling, mapping, et cetera.

If the property still looked interesting, Thayer would raise more risk money from his selected group of friends, say at twenty-five cents per share to get say $100,000. This would provide for more drilling or whatever was indicated to be done. Perhaps sinking a shaft, drifting and sampling on the mineralized zone. When expenditure of this money was favorable more work was done on the property, more shares sold to local friends at a higher price. This would continue until the property proved to be of no further interest or if a major mine development program was indicated. Money could be provided by a bank to get the orebody ready for mining and milling. At a point where the project was of proven value, shares of stock could then be sold to the public. That was one of the ways risk money could be provided until a property was ready to go into production. This procedure worked well in Canada and built up the list of mines in the Ventures Company.

Swent: Yes. Yellow Knife was a famous one.

Heikes: Yellow Knife has an interesting history.

Swent: Did you work on that?

Heikes: No, I didn't. That's way up in the far north and was in production when I was with Ventures, Ltd.

Swent: Do you think that this was a responsible way to build up a company?

Heikes: Yes. It certainly was responsible because Ventures wasn't raising the risk money from the public, but from Lindsley's mining friends who knew what they were doing and had confidence in his experienced judgment.

Swent: They would get their money back.

Heikes: Oh, yes. They would get their money many times over if the project was successful, and if it was not successful, the loss of the money didn't affect them, as they were wealthy and knew in advance of the risk they were taking, and either could afford it or not get involved in the first place.

Thayer Lindsley's brother, Halstead, was a mining engineer and financier. Thayer Lindsley was born in Japan. His father was an importer of Japanese goods into the United States. He sent Thayer to Harvard where he was graduated about 1900. Then Thayer went to Columbia University in New York and studied under Dr. James Kemp. Then he travelled around the world, looking at mineral deposits. Finally, he got a lease on the Iron Dike Mine near the Oregon-Idaho border and made about $30,000 net on that venture. That was his first one. With that money he and his brother Halstead started Ventures, Ltd.

When Lindsley died, he was a bachelor. He left money for the Lindsley Fund that pays for geological lectures at universities. I don't know if you read about it in the American Institute of Mining and Metallurgical Engineer Publications. The money is provided to further education in the mining business.

Swent: That's a good cause.

Heikes: Thayer Lindsley became a very famous man. Arnold Hoffman and his brother, Robert D. Hoffman, admired Lindsley and wrote about him in their book, Free Gold.[1] This is a very interesting and well-written book. I don't know whether you've ever seen it.

Swent: I have seen it. I have a copy of it.

Heikes: I'm glad to know you do have a copy.

Here is a Christmas card from Thayer.

Swent: That was a pleasant association then.

Heikes: That was a very pleasant association. I was glad I had a chance to work with him. While I was working for Lindsley, Kennecott wanted me to work for them at 120 Broadway. About that time, the Canadian government Foreign Exchange Control Board would not let us bring any money down from Canada for Mines, Inc., and I had to take Giant Yellow Knife stock and borrow some money from the Guaranty Trust Company in New York to keep Mines, Inc., alive until I could close it down. I was vice president of Mines, Inc., Ventures American subsidiary. Mines, Inc., had an interest in the Zellidja lead property near the Morocco/Algeria border, mercury mines in Italy, and several small properties in Idaho and elsewhere in the U.S.A. It had hardly gotten started before it had to be closed down because of lack of funds.

Swent: Did you work with Evan Just at all in New York?

Heikes: No, we didn't work together. He was my boss in Washington during the Korean War, when the Defense Material Procurement Agency was building our national stockpile of strategic materials.

Swent: In Washington.

Heikes: But he was top boss in Washington. I was in charge of mine development activity in Region IV, which was Africa and Europe. But Evan had the whole world building up a stockpile for the U.S. I think I met Evan when he was secretary of the Zinc Producers Association in Joplin, Missouri, many years ago, about 1937. He had a ranch in Oklahoma raising Angus cattle. I remember one day, he invited me to lunch at a hotel in Joplin with his adopted daughter, Karen, and his wife, Marion--she was a charming lady, one of the nicest women I ever met. We were climbing the stairs in the hotel, and there on a landing was a big stuffed moose head. You know how big a moose is. A great big full-size moose.

---

[1] Free Gold, the Stroy of Canadian Mining. [Hoffman, Arnold David. Rinehart & Co., Inc., New York and Toronto, 1947.]

Karen said, "Oh, mommy. Look at the big goat." I'll never forget that. That was when I was with National Lead, two years before World War II.

Swent: That's a long, long association there.

Heikes: Well, I guess that about covers it. I don't know how you're going to piece it together and make anything of it.

Swent: This has been a pleasure, Mr. Heikes.

Transcribed and final typed by Christopher DeRosa

TAPE GUIDE--George Conrad Heikes

Interview 1: August 1, 1991	1
Tape 1, side A	1
Tape 1, side B	10
Tape 2, side A	19
Tape 2, side B	not recorded
Tape 3, side A	27
Tape 3, side B	not recorded
Interview 2: August 2, 1991	34
Tape 4, side A	34
Tape 4, side B	40
Tape 5, side A	48
Tape 5, side B	54
Interview 3: August 10, 1991	61
Tape 6, side A	61
Tape 6, side B	69
Tape 7, side A	77
Tape 7, side B	not recorded

APPENDICES--George Conrad Heikes

A. Resume of George C. Heikes 83

B. "Operation Hardrock: A Mineral Exploration Project Based on Airborne Geophysics," by A.P. Subramaniam, 24th International Geological Congress, Canada, 1972. 86

C. Who's Who, 1944-1945, entry on Victor C. Heikes (father) 100

Appendix A

GEORGE CONRAD HEIKES
CONSULTING MINING GEOLOGIST
112 DOUGLANE AVENUE
SAN JOSE, CALIFORNIA 95117
PHONE (408) 247-3961

May 21, 1980.

RÉSUMÉ OF EXPERIENCE

SUMMARY

Over fifty years experience in mineral exploration, mine development and production. Exploration included aerial surveys, ground follow up, geologic mapping, diamond drilling, sampling, feasibility studies. Also "on the job" training of personnel in the U.S.A., Poland, Greece, Republic of Korea, India and Australia.

April 1973 to date: Consulting Mining Geologist, various clients Arizona, Nevada and California. Copper, tungsten, gold and silver prospects.

Feb. 1971 to March 1973: Chief Geologist. The Ralph M. Parsons Company Pty. Ltd. Australia. Examination of mineral deposits in New South Wales, Queensland, Western Australia, Indonesia including antimony, copper, ferrovanadium, gold, iron ore, lead, zinc, molybdenite, nickel, sapphires and tin.

June 1967 to January 1971: Project Manager. "Operation Hardrock" The Ralph M. Parsons Company, Pasadena, Calif. entered into a contract with the Government of India to prospect for copper, lead and zinc deposits in the States of Rajasthan, Andra Pradesh and Bihar/West Bengal. An airborne survey was done by Aero Services of Philadelphia, two PBY planes equipped for electro-magnetic, magnetometer, and scintillometer work covering 90,000 square kilometers. A central laboratory and two field laboratories were equipped. A staff of 110 geologists, geophysicists, chemists were selected from the Geological Survey of India to do the ground follow-up of anomalies and also to learn the latest techniques in the chemical and metallurgical laboratory. Finally, there were nine wireline drills to further investigate the most favorable areas followed by examination of core samples by microscopic, spectrographic and chemical analysis.

Sept. 1966 to May 1967: Mining Geologist, The Ralph M. Parsons Co., Los Angeles. Assisted in feasibility studies, ore reserve estimates, layout for a large open caste zinc-lead mine in the Yukon. Field investigations of copper, lead-zinc, mercury, potash, phosphate, and tungsten deposits in the U.S.A?

July 1964 to Aug. 1966: Minerals Consultant. Investigation of mineral deposits for various clients including deposits of iron ore, lateritic nickel, placer gold deposits, leaching of an old underground copper mine to produce cement copper, tungsten, bauxite, and ground water in the U.S.A. and Greece.

July 1960 to June 1964: Chief, Mining Division USOM/Korea. Agency for International Development, U.S. Department of State. Responsible for planning and directing mining division activities to aid Korean anthracite and metal mining companies. Advisor to the Korean Geological Survey and Bureau of Mines in the implementation of their programs related to preparation of quadrangle geological maps and augmenting production of anthracite coal, iron ore, lead-zinc, copper, tungsten, bismuth, tin, gold, heavy mineral sands, kaolin, marble and cement.

1953 to June 1960: Mining Geologist. Investigations of mineral deposits of iron ore, lateritic nickel, chromite, vanadium, uranium, copper, lead-zinc, bauxite, clay deposits,sand and gravel projects, limestone, light weight concrete aggregates, barite, pegmatites with beryl and ground water development. Among the clients were the M.A. Hanna Co. of Cleveland, Ohio, Van Alstyne & Noel, New York., and Continental Uranium, Grand Junction, Colorado.

1951 to 1953: Chief, Development Division D.M.P.A. Region IV. Defense Materials Procurement Agency headquartered in London, England, Region IV covered all of Europe and Africa. Assisted in negotiating contracts for strategic and critical materials to build up the U.S. Stockpile Program including copper, lead, zinc, tungsten, chromite, niobium (columbium), tin, cobalt, and industrial diamonds.

1949 to 1950: Chief, Mining Division ECA/Greece. Economic Cooperation Administration, Athens, Greece. Assisted in the rehabilitation of the Greek mining industry that had been seriously damaged by World War II and the Communist Revolution. Loans were granted to mining projects of merit including new enterprises to produce bauxite, chromite lignite, and manganese. Assisted in the organization of the Greek Institute for Geology and Subsurface Research and the preparation of a revised geological map of Greece on a scale of 1:1,000,000.

1948 to 1949: Executive Assistant to the Vice President of Exploration Kennecott Copper Corporation, New York. Co-ordinated work of exploration groups in the U.S.A. and Canada involved in aerial geophysical surveys, extensive ground follow-up, geologic mapping, geochemical investigations, and diamond drilling to define deposits of copper, lead and zinc, and titanium ores.

1945 to 1948: Vice President, Mines Inc., A fully owned subsidiary of Ventures, Ltd. of Toronto, Canada under Thayer Lindsley. Directed regional geological research in Alaska, Canada, Colorado, Idaho, and Nevada. Also in Italy for mercury, Morocco for lead-zinc, gold, barite, and non-metallic industrial mineral deposits.

1944 to 1945: Director, Aluminum -Magnesium Division, War Production Board, Washington D.C.

1943 to 1944: Manager, Aluminum Reduction Works, Tacoma, Washington. This was a Defense Plant operated for the U.S. Government by Olin Industries of East Alton, Illinois and was used as an experimental plant to extract aluminum metal from alumina made from alunite in a plant in Salt Lake City, Utah.

1942 to 1944: Director, Zinc Division, War Production Board, Washington, D.C.

1941 to 1942: Assistant Chief, Copper-Zinc Branch, Office of Production Management, Washington, D.C.

1937 to 1940: Chief Geologist and Assistant to the Consulting Engineer, National Lead Company and its fully owned subsidiary, the St. Louis Smelting and Refining Co., Combined Metals Reduction Co., Utah and Nevada, and other subsidiaries.

1936 to 1937: Chief, Non-Ferrous Metals Division, National Research Project, Works Progress Administration and U.S. Bureau of Mines. Co-author of a book on "Copper Mining".

1935: Assistant to the Consulting Engineer, Reading Coal and Iron Co. Philadelphia. Production was from surface and underground mines. There were fifteen collieries and two breakers, sales 8,500,000 tons of anthracite coal annually.

1926 to 1934: Chief Geologist, Giesche Spółka Akcyjna, Katowice, Upper Silesia, Poland. A subsidiary of Anaconda Copper Co. producing zinc, lead and bituminous coal. Conducted examination of mineral deposits that were brought to the attention of Anaconda in Poland, Germany, Norway, Spain, France, and Italy.

1924 to 1926: Trammer, timberman, mucker, miner, sampler and finally geologist for the Anaconda Group of mines consisting of the Neversweat, Anaconda, St. Lawrence and Belmont.

EDUCATION AND TECHNICAL SOCIETIES

Grammer and two years High School, Salt Lake. Two years Mercersburg Academy, Mercersburg, Penna. Four years Lehigh University, Bethlehem, Penna. B.A. Geology 1923. Also took courses in mining engineering, ore dressing and metallurgy. Senior Member Am. Inst. Mining & Metallurgical Engineers, Society Economic Geologists, Canadian Inst. Mining and Metallurgy and Member Am. Inst of Professional Geologists No.1599, Registered Geologist No. 2841 Calif., Arizona No. 9219. Am. Citizen.

Operation Hardrock — A Mineral Exploration Project Based on Airborne Geophysics

A. P. SUBRAMANIAM, ← Died of a heart attack Apr. 22, 1973
India
—Hilcox

ABSTRACT

About 90,000 km² of potential ore-bearing terrain in parts of Rajasthan, Bihar-Bengal and Andhra Pradesh States of India, underlain by favourable geological formations, was covered by airborne geophysics using electromagnetic, magnetic and radiometric systems in two different aircraft. The aero-electromagnetic responses were recorded with MARK-V INPUT and continuous-wave electromagnetic systems, the aero-magnetics with Nuclear Precession and Fluxgate magnetometers, and radiometry with a total-count scintillometer. These flight lines, spaced at either ½ km or 1 km, were oriented across the regional trend of the rock units. Significant EM aero-anomalies were evaluated in the context of their geological setting, magnetic and radiometric association. Over 11,000 aero-anomaly intercepts were selected for ground geological reconnaissance, aided where necessary by geochemistry and geophysics, in order to locate suitable targets for integrated ground surveys. Over 700 aero-anomalies have so far been covered by integrated surveys involving electromagnetic, magnetic, self-potential and induced polarisation techniques, together with geochemical sampling and geological observations. As a result, over 25 targets have emerged, of which a dozen have been tested by diamond drilling.

So far, six promising prospects of sulphide mineralization have been located in Rajasthan, Andhra Pradesh and Bihar, four of copper and two of zinc-lead. One of the copper prospects located in Bihar carries associated nickel and cobalt; the zinc-lead prospects in Rajasthan carry appreciable values in silver. These prospects are now being investigated in detail by drilling. The EM data have also been interpreted to outline zones for ground-water search with rewarding results. The role of environmental factors in geophysical exploration is discussed.

INTRODUCTION

A MINERAL EXPLORATION PROJECT, with airborne geophysics as the initial phase, was implemented by the Government of India to accelerate the pace of exploration for base metal mineral deposits. India's requirements of these metals are at present being met mostly by imports.

This project, called 'Operation Hardrock', commenced in July, 1967, with financial assistance from the U.S. Agency for International Development. An

---

Authors' addresses are given at the back of this book.

area of over 90,000 km^2 was covered by airborne geophysical surveys (Plates 1, 2a, b & c) as detailed below: —

Area	Km^2	Line km	Coverage
(1) Rajasthan	30,140	58,385.5	(74 per cent INPUT)
(2) Bihar-West Bengal	29,750	53,416.0	(16 per cent INPUT)
(3) Andhra Pradesh	30.500	32,660.5	(100 per cent INPUT)

AIRBORNE GEOPHYSICS

Aero Service Corporation of Philadelphia carried out the airborne geophysical surveys in close collaboration with the Airborne Mineral Surveys and Exploration wing of the Geological Survey of India. Of the two aircraft used, one was a Super Canso equipped with a Barringer Mark-V INPUT EM system, a Barringer AM 101 Nuclear Precession magnetometer and a total-count scintillometer; the other was a Canso, equipped with a Canadian Aero Service Mark III In-phase/Out-of-phase (Aero Newmont) Continuous Wave System, a Gulf Research Mark III Fluxgate magnetometer and a total-count scintillometer. In all, about 91,000 line kms were flown with the INPUT EM system and the re-

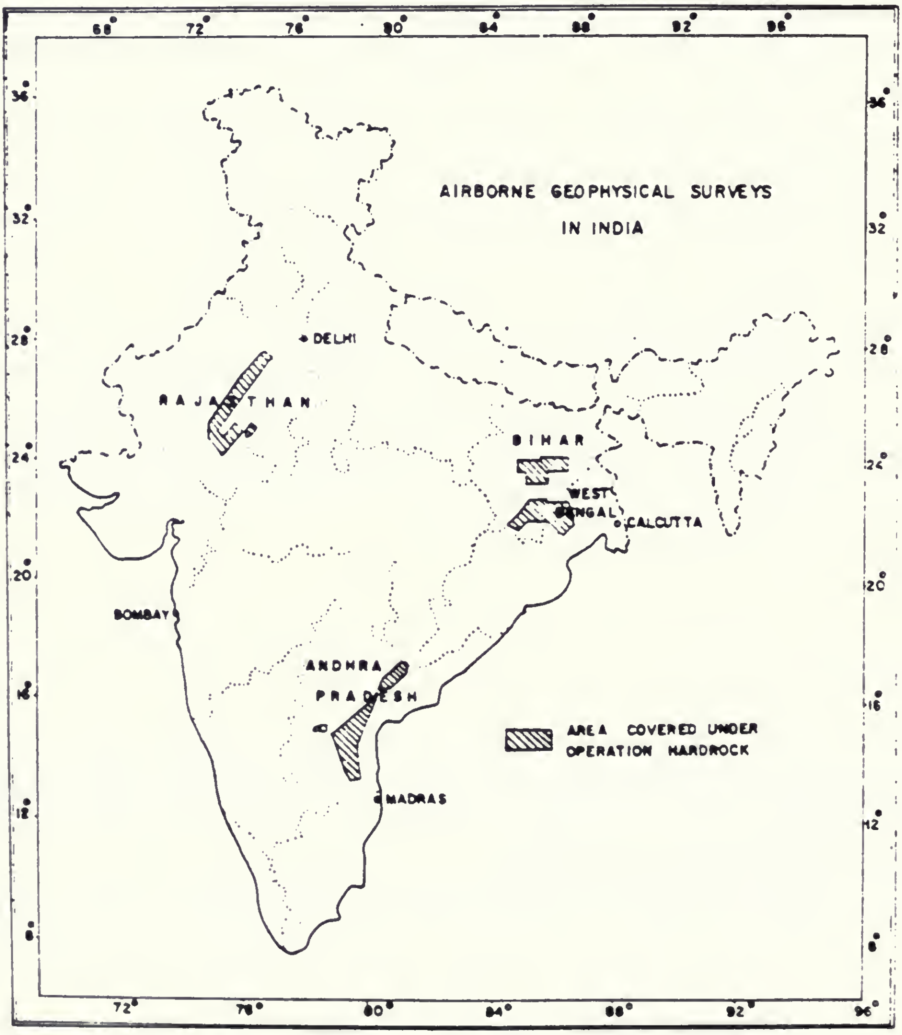


FIGURE 1 — Airborne geophysical surveys in India.

maining 53,000 line km with the Aero Newmont CWEM system. Each aircraft had other ancillary equipment, such as a radio altimeter and a 35-mm tracking camera, and a ground-based magnetometer recorded the diurnal variation of the earth's total magnetic field in the survey area. All data were recorded on analog charts, with additional digital print-out for the Proton magnetometer. As the area flown is not characterised by a thick profile of conductive overburden, the EM responses recorded by both systems were very satisfactory. Photomosaics were used for navigation, the flight paths being oriented across the regional trend at a spacing of ½ or 1 kilometer. Flight-path recovery and co-ordination of data records on base overlay maps were carried out daily at the airbase.

AERO-ANOMALY GRADATION

General

All the data were plotted on overlay sheets displaying the location of the electromagnetic aero-anomaly intercepts on recovered flight paths giving their conductivity magnetic and radiometric responses and flight altitude. The initial exercise involved elimination of many of the EM responses due to electrical transmission lines, railway lines, etc. The electromagnetic responses recorded on conductive rocks, such as graphitic schists and carbonaceous shales, without any associated magnetic response, and those caused by saline waters, etc. were also eliminated by study of the photomosaics and geological maps. The flight altitude was also taken into consideration in evaluating the aero-anomalies.

Electromagnetic Responses

The electromagnetic responses recorded on the INPUT system were evaluated on the basis of their channel response, shape and width, pattern of occurrence, amplitude and rate of decay. A response of all the six channels with high amplitude and slow decay rate was graded as an anomaly of the first order. The electromagnetic responses with diminishing order of channel response and faster decay rate were rated as second- and third-order responses.

The responses measured on the CWEM system were evaluated on the basis of the ratio between in-phase and out-of-phase components and the amplitudes: where the in-phase and out-of-phase ratio was 3 or more they were rated as responses of the first order; where the ratio ranged from 1.5 to 3 they were rated as second order, and from 0.75 to 1.5, third order.

Magnetic Responses

Magnetic variations were recorded at discrete intervals by the Proton magnetometer and continuously by the Fluxgate magnetometer. In evaluating electromagnetic responses, those characterised by a favourable magnetic association were given a high rating. The aero-magnetic data also reflected the structural pattern of the terrain, thereby aiding in anomaly evaluation.

Radiometric Responses

The total-count scintillometer recorded the radiometric response, which, in addition to indicating the possible presence of radioactive mineralisation, also provided guide-lines for locating zones of sulphide mineralisation which often carry associated radioactive minerals.

Gradation of Anomalies

The index of gradation can be defined as a function principally of the conductivity characteristics, magnetic association and favourable geological environment. Other influencing factors, such as discreteness, isolation and the shape of the EM anomaly zones and the scintillation responses, have also been taken into account. Grade-I anomalies are those in which all the principal variables are ideally associated. Grade-II anomalies include those which are characterised by an association of at least two variables. Anomalies defined by any one of three variables, especially the geological setting, fall under Grade-III. This gradation and classification of the anomalies has been based primarily on a study of the data sheets compiled immediately after the conclusion of the airborne geophysical surveys.

These surveys resulted in thousands of EM aero-anomalies, which by analysis on the above basis have been graded into 6,000 of Grade-I, 3,000 of Grade-II and 2,000 of Grade-III, making up 11,000 aero-anomaly intercepts meriting ground check. It must be emphasized that this gradation, which is based on instrumental responses and available geological information, should only be used as a guide.

GROUND FOLLOW-UP

General

The ground follow-up involved geological reconnaissanse followed by integrated surveys with simultaneous application of geochemistry and geophysics of selected aero-anomalies. The main objectives of this reconnaissance were location of the conductors on the ground, deciphering the geological setting of the aero-anomalies and a rapid geochemical check to determine the presence of heavy metals. The integrated follow-up involved geological mapping, geochemical sampling, electromagnetic and magnetic surveys supplemented at places by induced polarisation and spontaneous polarisation surveys.

Electromagnetic Surveys

The location of the EM conductors picked up by ground geophysics correlate closely with the aero-anomalies, large deviations being rare. The vertical coil in-line and set-up methods were employed for locating the causative source of the EM aero-anomaly and for ascertaining its approximate strike extent. Transmitter-receiver (Tx-Rx) separations of 120 and 150 metres were used for the in-line measurements. The EM conductors identified were detailed by horizontal-coil in-phase and out-of-phase measurements with different Tx-Rx separations of 90, 60 and 30 m. Where the horizontal-coil method did not pick up the conductor, the vertical-coil broad-side method was used with larger Tx-Rx separation (120 to 200 m). Traverse intervals varied from 30 to 200 m, and the station spacing was 15 or 30 m.

The data obtained have been plotted as profiles of tilt angles indicating 'cross over' above the conductor or in-phase and out-of-phase values ('lows' representing conductor locations). The conductivity-thickness products and depths of conductors computed from in-phase and out-of-phase responses were estimated using model curves (Ramachandran Nair, *et al.*, 1968), which gave good approximations of the depths. Contour maps of both components were made to study the attitude of the conductors.

Magnetometric Surveys

Observations of the relative variations in the vertical component of the magnetic field were made using Fluxgate and Torsion magnetometers along most of the EM traverses to evaluate the conductors. Magnetic traverses on the ground were also helpful in picking up certain marker horizons and deciphering structural features.

Induced Polarisation Surveys

Induced polarisation surveys (time domain and frequency domain) were made generally over aero-anomaly intercepts where the geological features and geochemical responses were very good but responses from ground EM surveys poor or weak.

For frequency-domain I.P. surveys carried out in parts of Rajasthan and Bihar, the dipole-dipole array was used, with dipole length varying from 30 to 150 m. Shorter dipole separations of 10 and 20 m were useful for resolving the broad I.P. responses due to multiple conductors. Frequencies of 3.0 c/sec. and 0.1 c/sec, were used to measure the resistivity and polarisation effect.

Interpretation of the observed IP-resistivity data for dipole array was made from vertical pseudo sections showing the plot of 'apparent resistivity', per cent frequency effect (P.F.E.) and metal conduction factor (M.C.F.). The qualitative estimate of the location and width of the sub-surface conductor was made from the surface projection of resistivity, P.F.E. and M.C.F. anomalies defined by zones of higher gradient and closed contours.

I.P. surveys (time domain) were made on some aero-anomaly zones in the Andhra Pradesh area using gradient, 3-pole, Wenner and dipole arrays, with separations ranging from 10 to 180 m. The observed apparent resistivity and chargeability were plotted as profiles and contour plans to make qualitative estimates of the depth, disposition and lateral extent of the body.

Spontaneous Polarisation

Spontaneous polarisation surveys were carried out in parts of Andhra Pradesh as a supplement to EM and I.P. surveys. S.P. contour plans were prepared and S.P. negative centres located.

Geochemical Methods

Determination of the heavy metal content in soil and rock-chip samples by a cold extraction technique in the field itself has been helpful in the rapid evaluation of aero-anomalies. The method for estimating heavy metals (Cu, Pb, Zn, Ni, Co, Ag, Sn) involves the use of dithizone as a preferentially complexing agent. Based on positive indications, geophysical surveys were made for establishing the behaviour of the causative source. On an average, for each aero-anomaly intercept, at least 12 samples were subjected to field test during reconnaissance, and at the detailing stage as many as 60 to 200 samples were analysed in the field. Samples collected at this stage were analysed by atomic absorption spectrophotometry for characterisation of elements comprising the heavy metal group. So far, 113,000 estimations have been made on nearly 39,000 samples representing soils, stream sediments, rock chips and drill cores. Targets for test drilling were chosen where the geochemical and geophysical anomalies showed a close coincidence. Stream-sediment sampling to evaluate the causative source of broad zones of aero-anomalies occurring in favourable geological setting has yielded significant results which are being followed.

Photogeology

Photogeological studies were helpful in deciphering major structural elements such as faults and folds, stratigraphic breaks and lithological variations, providing useful data to the field geologists engaged in reconnaissance evaluation of aero-anomalies. Valuable information was also provided for interpreting shallow EM conductors inferred to be zones of ground-water saturation.

Airborne Data for Ground-Water Exploration

Broad zones of EM responses indicating shallow conductivity were correlated with geological and geomorphological setting using air photos. Drilling in some zones thus outlined in low-grade metamorphites and compact sediments in Andhra Pradesh (Figure 2c) has yielded water to the extent of 5,000 to 8,000 gallons per hour.

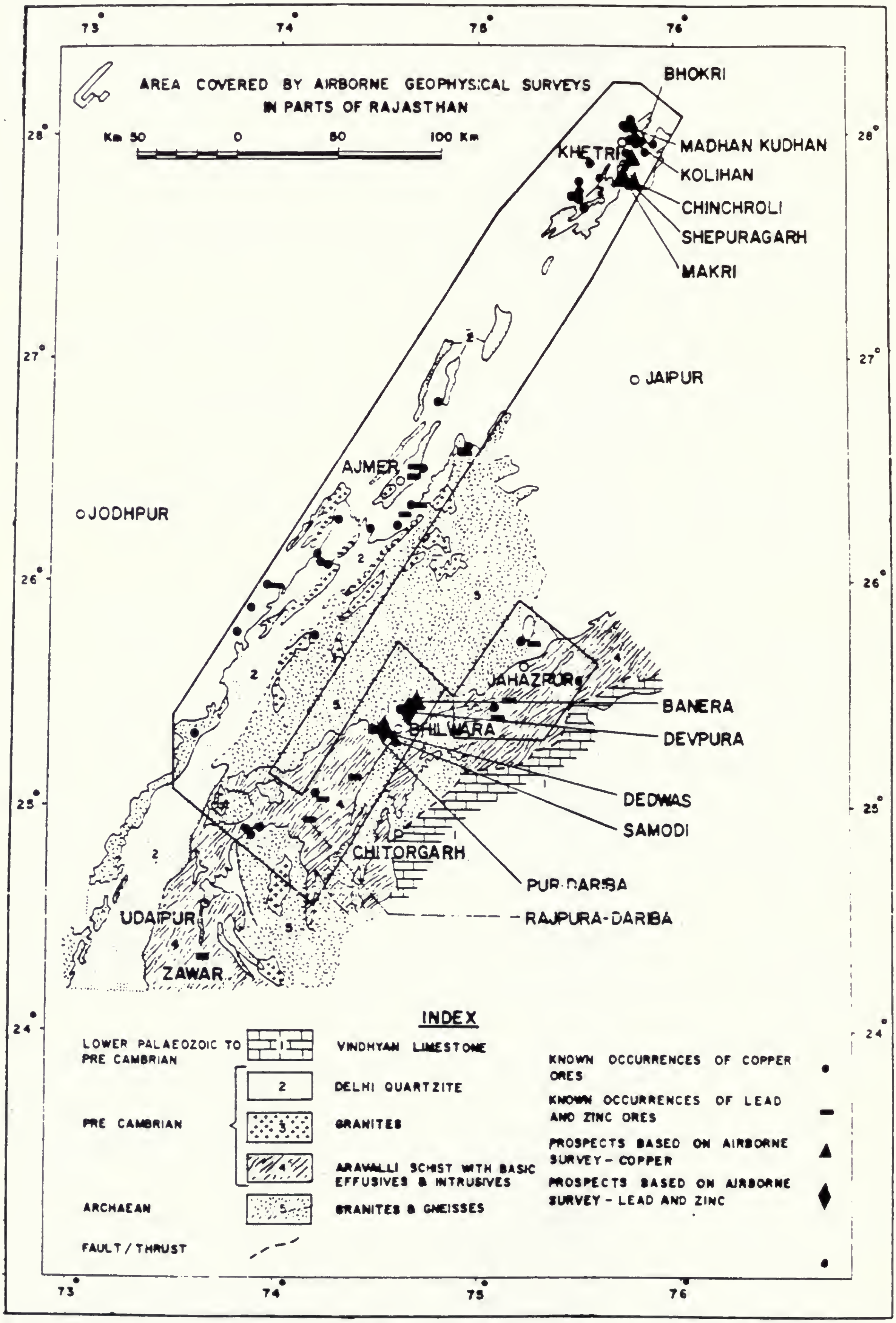


FIGURE 2(a) — Area covered by geophysical surveys in parts of Rajasthan.

GEOLOGY OF OPERATIONAL AREAS

General

Besides the geological framework, other factors which weighed in favour of the selection of areas were the host rock environment, presence of mineral shows and the occurrence of many ancient workings for copper, lead and zinc. Figures 2a, b and c detail the regional geology and indicate the generalised stratigraphic sequence, the location of old workings, and new prospects which have emerged as a result of this airborne geophysical survey. A detailed account of the geology of these areas can be obtained from Krishnan (1968).

Rajasthan

The operational area in Rajasthan is located between Khetri in the north and Udaipur in the south and is designated as the Khetri-Ajmer, Bhilwara and Jahazpur blocks (Figure 2a). The area is occupied by rocks of the gneissic complex, overlain by rock units of the Aravalli and Delhi groups, all of Precambrian age, cut by later granites. The meta-sedimentary units of the Aravalli Group, which include basic sills, show a distinct northeasterly structural trend, often referred to as the Aravalli trend. The rock types of the Aravalli group are essentially green schists, but narrow bands of rocks of intermediate-pressure amphibolite facies characterised by andalusite +staurolite assemblages, and of the typical Barrovian-type, also occur. The rocks of the Delhi Group are essentially quartzites and phyllites. Vindhyan rocks comprising sandstones, limestones and conglomerates are exposed on the southeastern margins of the operational area, separated from the older rocks by the great boundary fault.

This area had flourishing mining activity during historic times as evidenced by many old workings, mine dumps and slag heaps. The old workings in the Khetri area, including Kolihan and Madhan Kudhan, are now under development; there are also groups of old workings for copper south of Khetri. At Zawar and Rajpura in the Ajmer-Udaipur area there are many old workings for lead and zinc; the Zawar mines are now under active exploitation. In the southern part of the flight area, this airborne survey has brought to light a mineralised tract extending from Pur Dariba in the south to Banera in the north. This includes a potential zinc-lead ore zone in the vicinity of Samodi, Dedwas and Devpura, and a copper ore zone south of Banera.

Bihar - West Bengal Area

The Bihar - West Bengal operational area (Figure 2b) comprises parts of the Singhbhum Copper Belt and areas adjacent to it and the Bihar Mica Belt. These areas are designated as Bihar south and north blocks respectively. The metamorphic rocks in these flight areas are of the greenschist, amphibolite and granulite facies, with some zones showing pluri-facial metamorphism.

Bihar South Block

The geological formations in this area are of Precambrian age, comprising in the north the Ranchi granite, the Chota Nagpur granite gneiss with intercalated metabasites, mica schists, quartzites and meta-volcanics referable to the Iron Ore, Dalma and Dhanjori groups. The southern margin of the area is occupied by the Singhbhum granite.

The Singhbhum copper belt, extending over a length of 150 km along a major thrust zone, forms a broad arc with a northeasterly convexity. There are several zones of sulphide mineralisation in this belt, one of which, at Mosabani, is currently being exploited for copper. Another important copper prospect at Rakha, and the only producing uranium mine, fall within this belt. This shear or thrust zone is along the overfolded southern limb of a geoanticline.

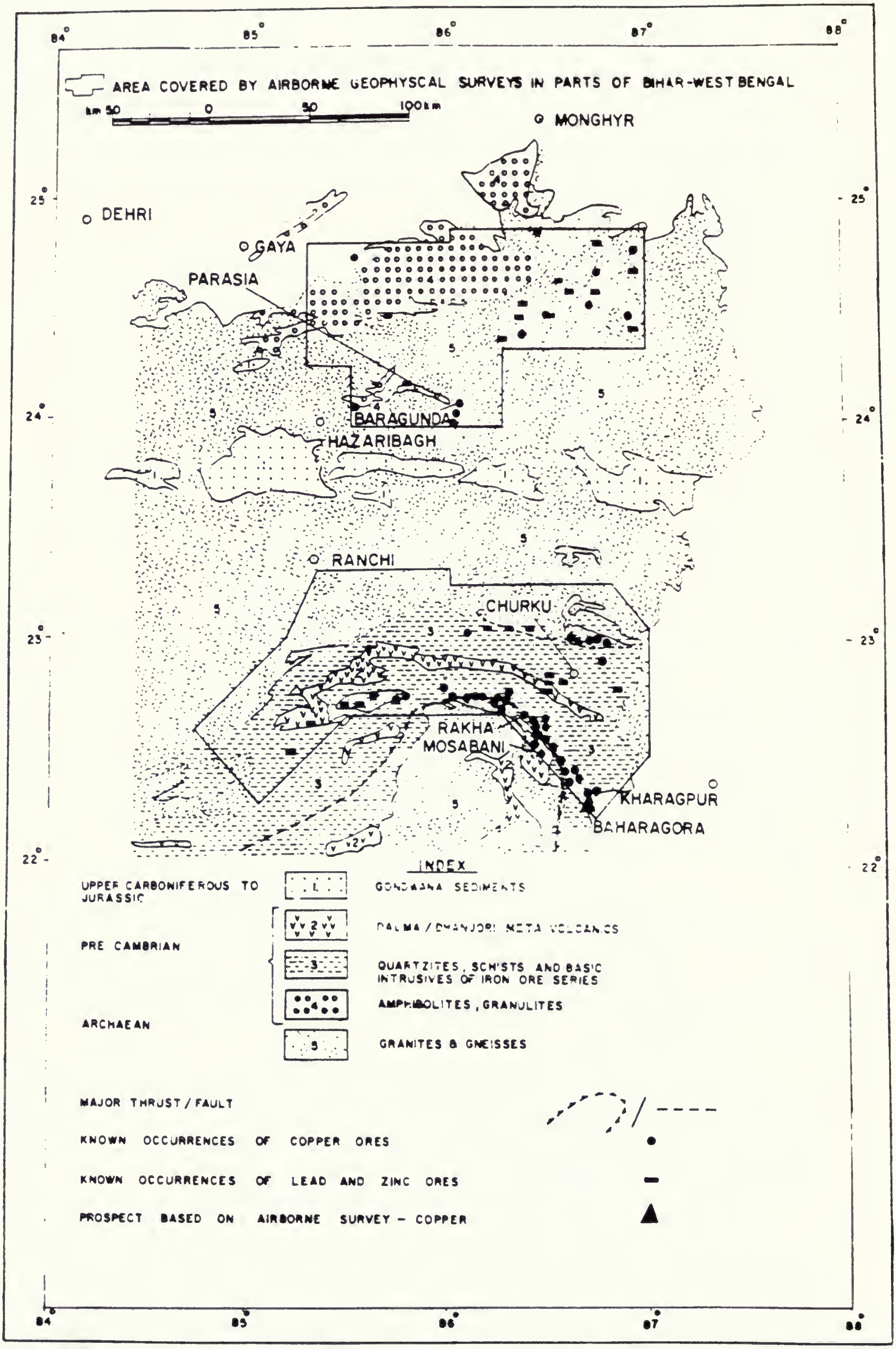

84°
85°
86°
87°
88°
AREA COVERED BY AIRBORNE GEOPHYSCAL SURVEYS IN PARTS OF BIHAR-WEST BENGAL
km 50 0 50 100 km
MONGHYR
25°
DEHRI
GAYA
PARASIA
BARAGUNDA
HAZARIBAGH
24°
RANCHI
CHURKU
23°
RAKHA
MOSABANI
KHARAGPUR
BAHARAGORA
22°
1
2
3
4
5
INDEX
UPPER CARBONIFEROUS TO JURASSIC
GONDWANA SEDIMENTS
PRE CAMBRIAN
DALMA / DHANJORI META VOLCANICS
QUARTZITES, SCHISTS AND BASIC INTRUSIVES OF IRON ORE SERIES
AMPHIBOLITES, GRANULITES
ARCHAEAN
GRANITES & GNEISSES
MAJOR THRUST / FAULT
KNOWN OCCURRENCES OF COPPER ORES
KNOWN OCCURRENCES OF LEAD AND ZINC ORES
PROSPECT BASED ON AIRBORNE SURVEY – COPPER

FIGURE 2(b) — Area covered by airborne geophysical surveys in parts of Bihar-West Bengal.

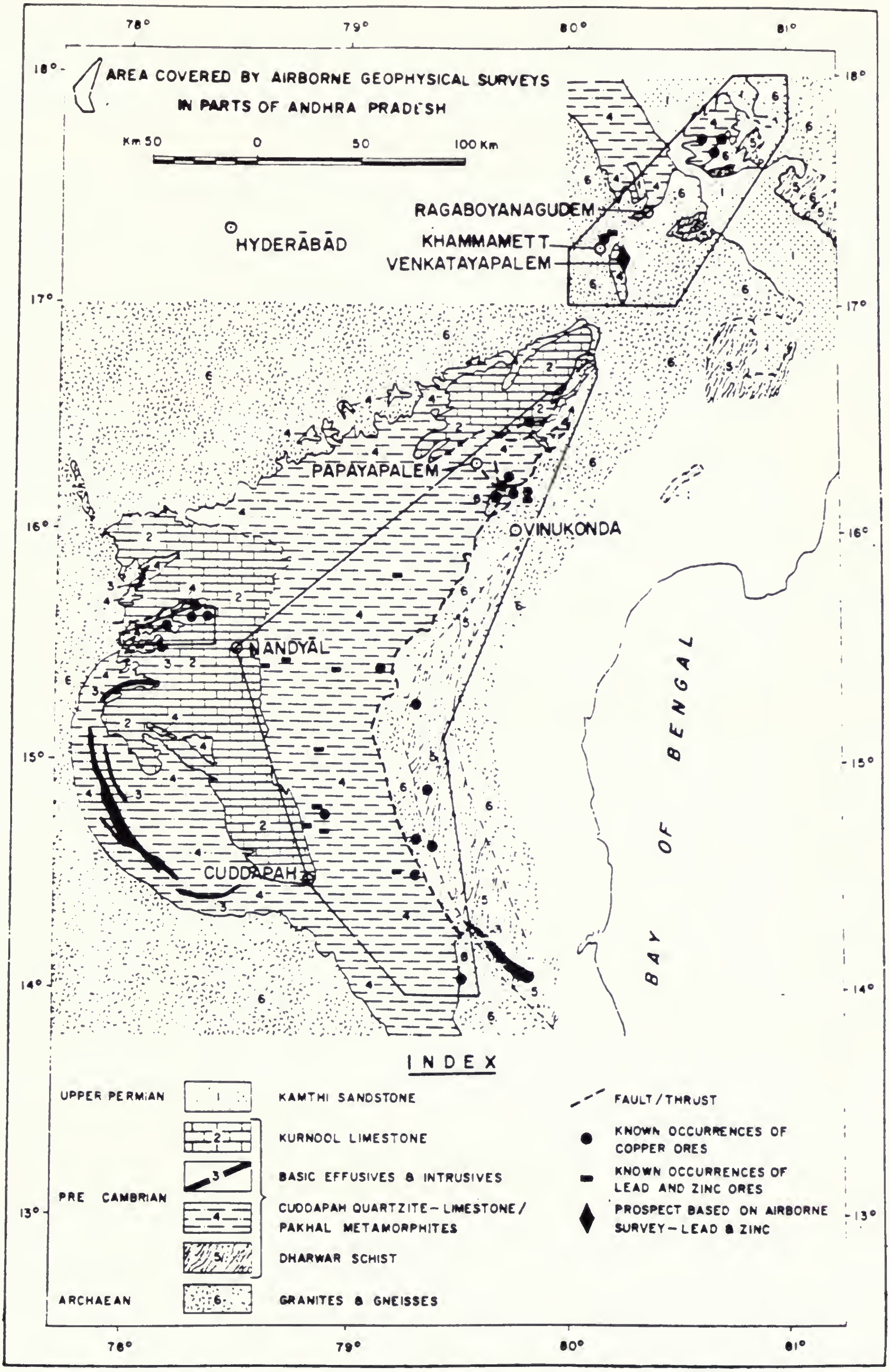


FIGURE 2(c) — Area covered by airborne geophysical surveys in parts of the Andhra Pradesh.

There are reported occurrences of copper and lead mineralisation in the Purulia-Bankura shear zone, trending east-west for over 30 km, located about 50 km north of the Singhbhum shear zone.

Bihar North Block

The geological formations in this area are of Precambrian age, comprising quartzite, garnetiferous mica-schists, granitic gneisses and intrusive domical granites and sills of metabasites which have a regional east-west trend with steep northerly dips. A zone of pegmatites occurs within the mica shists extending some 100 km in the Gaya and Monghyr districts. Farther south, between Parasia and Baraganda, there is a weak shear zone trending north-northwest, marked by a few occurrences of copper, lead and zinc mineralisation.

Andhra Pradesh Area

The surveys in Andhra Pradesh were made in three distinct blocks, much of the flights being confined in the eastern margin of the crescent-shaped Cuddapah basin, occupied by rocks of the Cuddapah and Kurnool Systems of Proterozoic age (Fig. 2c). The Cuddapah rocks have been deposited on a steeply dipping basement of Archaean rocks and are essentially pelitic, calcareous and arenaceous assemblages, mostly shales, limestones and quartzites. There are many basic flows, sills and dykes within the Cuddapah rock units, particularly in the southwestern part of the flight area. The Cuddapah basin has on its western margin gently dipping beds, whereas on the eastern margin they are intensely folded and faulted. Several strike-slip faults, thrusts, domal structures and monoclinal flexures are also inferred.

In the Gani-Kalava flight area on the western margin, the rocks are essentially quartzites and limestones of the Kurnool system overlapping the lower Cuddapah slates and shales. In the Khammam flight area to the north, there are phyllites or amphibolites with interstratified dolomites and quartzites referred to as the Pakhal series (equivalent to Cuddapah, in age) flanked by amphibolites and schists of the Dharwar Group. Much of the operational area is occupied by well-compacted sedimentary units which at places show incipient metamorphism. Rocks of the greenschist and amphibolite facies flank the eastern margin of the Cuddapah basin. In the Khammam area to the north there are amphibolite-facies rocks of the Dharwar as well as greenschists and intermediate-pressure amphibolites of the Pakhal series characterised by andalusite+staurolite.

There are innumerable old workings for copper, lead and zinc in the Cuddapah basin and adjacent areas. Zones of copper and lead mineralisation around Agnigundala northwest of Vinukonda have been explored in great detail over the last ten years by the Geological Survey.

CASE HISTORIES

General Review

Over 6,000 anomaly intercepts, mostly of the first and second grades, have been so far checked on the ground and more than 700 of them subjected to detailed integrated studies, resulting in the emergence of over 25 targets suitable for test drilling. The validity of locating the causative source of an aero-anomaly after ground geophysics and geochemistry has been proved. Nearly 20,000 m of drilling has been carried out in many targets involving a probe on 45 delineated conductors. Of these, conductors comprising six prospects have given encouraging results. Most drill holes have intersected zones of sulphide mineralisation comprising pyrite, pyrrhotite and chalcopyrite with magnetite in the copper-bearing zones; and galena, sphalerite, pyrite, pyrrhotite and magnetite in the zinc-lead prospects. A few drill holes have also passed through zones with as much as 20 to 25 per cent pyrite+pyrrhotite and only traces of copper. Silver, cobalt, molybdenum and nickel have also been detected in some of the sulphide zones.

The causative source, as revealed by diamond drilling, of some promising aero-anomalies around Ajit Sagar in Rajasthan and at Churku in Bihar proved to be an assemblage of sulphides with lean values of copper and molybdenum and a graphitic association. A drill hole at the aero-anomaly near Shepuragarh in Rajasthan revealed the causative source to be a zone of shattering filled in by saturated clays and gouge, with the country rock itself carrying disseminated grains of pyrite. At Makri in Rajasthan the causative body was essentially pyrite +pyrrhotite in a carbonate host rock. In two of the three prospects drilled in Andhra Pradesh, the causative source was sulphide mineralisation with lean values of copper and lead in a carbonate host rock.

Dedwas-Devpura-Banera Prospect, Rajasthan

A linear zone of about 15 km between Samodi and Banera south of Bhilwara in Rajasthan showed first-order EM responses measured on the CWEM system, with associated high magnetic values. This zone is marked by the presence of some old workings, particularly near Devpura and Banera. The rock types exposed in this zone are dolomites interstratified with cummingtonite-grunerite-magnetite schist and garnetiferous mica schist trending roughly NNE-SSW with vertical or steep dips. The EM and magnetic responses are attributable to the narrow zone of magnetite-grunerite schists which carry appreciable amount of pyrrhotite.

Geochemical sampling along this anomaly zone disclosed several peaks with high zinc values. Analysis of the EM model curves indicated the depth of the causative source to be about 19 m below the ground and the conductivity thickness product to be of the order of 120 mhos. The geochemical anomalies correlate closely with the ground geophysical data and the geological expression.

Drilling carried out so far in this area has encountered zinc-lead mineralisation with pyrite, pyrrhotite and magnetite. In the Dedwas prospect, at the southern end of this linear belt, zones of sulphide mineralisation assaying nearly 4 per cent Zn + Pb with appreciable silver values have been proved over a strike length of nearly 1 km and have been traced as discontinuous lenses farther to the north. A 450-m-long zone of similar zinc-lead mineralisation has been proved in the Devpura area farther to the north of Dedwas.

In the Banera area, in close proximity to Devpura, copper mineralisation has been intersected over a strike length of over 200 m. In general, the pattern of mineralisation in this zone suggests ore shoots of small dimensions with high metal values, at places distributed in broad stratabound zones carrying moderate to low metal values.

Chinchroli Prospect, Rajasthan

The Chinchroli aero-anomaly zone in Rajasthan, located about 25 km south of Khetri, is marked by the presence of sporadic outcrops of quartzites, biotite-chlorite schists, quartz-magnetite schists and carbonate breccia, trending NNE-SSW with steep westerly dips. EM surveys carried out over a 6-channel INPUT aero-anomaly with a slow decay rate and favourable magnetic association for locating the conductor on the ground did not show any significant response, but IP surveys with hundred-metre dipole length located a conductor. Although geochemical response near the aero-anomaly was poor, there was a sufficiently promising surface expression of mineralisation in the brecciated rocks exposed in the vicinity to warrant test drilling.

Drilling along the strike extension of the mineralised zone, inferred to be about 2 km on the basis of integrated ground surveys, has indicated the existence of parallel zones of sulphide mineralisation 3 metres wide assaying over 1 per cent copper. Assay results showed the presence of appreciable values of cobalt in a recent intersection in this mineralised zone; high copper values have also been found in thin bands within the zones of mineralisation. This aero-anomaly is of significance in view of the fact that there are no signs of ancient workings nearby.

Baharagora Prospect, Bihar

A zone of seven aero-anomalies was picked up by the CWEM system about 3 km NNW of Baharagora — a site of ancient mining activity. The EM responses classified under the second or third order had a favourable magnetic association.

The area around Baharagora is mostly under cover of Tertiary gravels and laterite soil with sporadic rock outcrops. Exposures of magnetite-bearing intrusive granites occur west of the anomaly zone with mica schists and phyllites, metabasites, quartzites, quartz schists and garnetiferrous mica schists with northeasterly dips outcropping to the northeast. The shape of this intrusive granite is reflected in the aeromagnetic map.

The area was covered by induced polarisation surveys at line intervals of 150-300 m and with a dipole length of 150 m. Detailing at a 30-m dipole length was done in promising areas where a geochemical anomaly had been delineated. EM surveys made in the zone of old workings south of Jharia and along good geochemical anomaly zones gave positive responses with low amplitude.

Targets which had good geochemical response and positive IP-RES data along old workings were initially subjected to test drilling. With the intersection of two promising zones of sulphides with good copper values in the very first drill hole, drilling was extended to establish the width and the strike length of the orebody. Integrated ground surveys have established the surface extension of the mineralised area of over a length of 3.5 km.

Drilling carried out so far has intersected zones of mineralisation assaying more than 2 per cent copper over a width of 3 m in two sub-parallel zones, with a strike length of over 600 m. Near the southwestern axis of the two zones, one of the drill holes intersected a 1-m-wide mineralisation section assaying over 3 per cent nickel and 0.3 per cent cobalt.

Venkatayapalem Prospect, Andhra Pradesh

A 4-channel INPUT EM anomaly located on dolomites in the linear ridge of Pakhal formations about 2 km west of Venkatayapalem has associated magnetic and radiometric responses in the adjacent flight lines. The rock units exposed in the area are quartzites, dolomites, phyllites and cherts of the Pakhal Formation, trending N 15° E with high westerly dips, flanked by Archaean gneisses and amphibolite. Based on positive geochemical responses, twelve IP traverses, aligned N 70°E and S 70°W along the aero-anomaly zone, indicated three conductive axes. one of which coincided with the aero-anomaly and the geochemical anomaly. A few S.P. indications were also obtained close to the IP and EM anomaly zones, confirming the presence of a conductive body. Two drill holes have intersected lead-zinc mineralisation assaying nearly 6 per cent total metals (Pb+Zn+Cu) over a width of 2.34 m and 3 per cent Pb+Zn over a width of 1.95 m.

CORRELATION OF AIRBORNE DATA WITH RESULTS OF GROUND FOLLOW-UP

The environmental factor plays a vital role in meaningful interpretation of airborne geophysical data. There have been comments on the doubtful utility of airborne EM systems in tropical countries with conductive overburden (Pemberton and Seigel, 1968). This may be true only where a thick profile of weathering and consequent overburden is present and cannot be a generalisation for tropical environments. In essence, all airborne geophysical data represent contrasts in the physical properties of the terrain flown and only a careful evaluation of the geophysical parameters in the light of the geological setting will aid in drawing up a programme of mineral exploration. It is in this selective picking up of targets that geochemical methods play a vital role. Application of rapid methods of sampling and estimation of heavy metal content has helped greatly in getting an insight into the association of metals in the causative source. Systematic sampling methods and fully quantitative determinations of elements in the samples correlated with ground geophysics was an essential exercise to be gone through for the selection of targets for probe by drilling. The present status of knowledge from 'Operation Hardrock' perhaps permits the following generalisations.

(1) This survey has established the usefulness of rapid reconnaissance by airborne geophysics to delimit targets for detailed exploration. The emergence of six prospects of Pb, Zn and Cu, any one of which might prove to be a workable orebody, within four years of commencement of this project supports this contention.

(2) The system of aero-anomaly evaluation based on instrumental responses and geological setting, using the latter aided by geochemistry as the prime factor, has established in the various targets drilled that the causative source was sulphide mineralisation.

(3) The data interpretation is valid only to the extent that it is supported by reconnaissance geological and geochemical evaluation of these anomalies.

(4) In the operational areas in this project the thin profile of weathering has permitted the use of geochemical methods to correlate the physical parameters obtained by airborne and ground geophysics.

COST AND TIME FACTOR

The U.S. Agency for International Development extended a loan of $(U.S.) 3.5 million to finance the foreign exchange budget of the Project. Out of this allotment, only $3.32 million was actually spent. The airborne geophysical survey cost $1.62 million and the balance of $1.70 million was utilised for import of laboratory equipment, ground geophysical instruments and spares, vehicles, wireline drilling equipment and accessories, and payment to the contractors for technical services rendered.

To the end of October 1971, an additional sum of nearly 33 million rupees ($4.40 million) has been spent on the ground follow-up programme involving reconnaissance, integrated geochemical, geophysical and geological exploration, diamond-drilling of nearly 20,000 m and analysis of several thousands of samples. The over-all cost of this programme of exploration up to the end of October, 1971 has been of the order of 58 million rupees ($7.72 million). This expenditure represents the total outlay on the capital equipment which continues to be deployed on the project and the cost of airborne geophysical coverage of an area of 90,000 km^2 involving over 144,000 line km of flying, evaluation by reconnaissance of over 6,000 aero-anomaly intercepts, detailed integrated surveys of over 700 of these intercepts, diamond core drilling of over 20,000 m and analysis of over 39,000 samples involving 113,000 estimations. The time schedule for the above operation can be briefly stated as follows:

	Approximate period of operations	Date of commencement
Airborne geophysics	10 months	July 1967 — May 1968 completed.
Reconnaissance ground surveys	46 months	January 1968 — in progress
Detailed integrated surveys	37 months	October 1968 — in progress
Drilling	32 months	March 1969 — in progress

The project started with the first phase of airborne geophysics in July 1967, which was completed in ten months. Ground reconnaissance commenced from the beginning of 1968, detailed integrated surveys on selected targets in October, 1968 and diamond core drilling on conductors based on integrated ground studies in March 1969. It can, therefore, be seen that, in a matter of 52 months, the above quantum of exploration has been achieved, resulting in the location of six prospects of some promise. The results achieved favour the continuation of exploration programmes for covering large areas oriented with airborne geophysics as a guideline to locating promising prospects in a short time.

ACKNOWLEDGMENTS

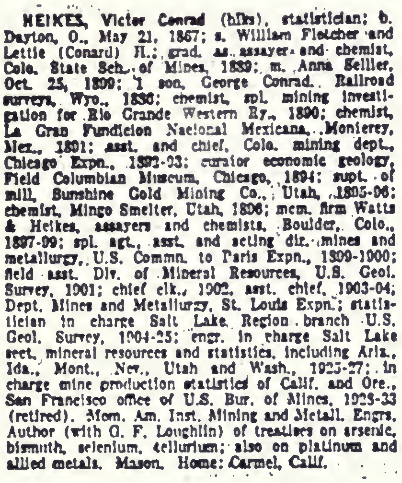
This report represents a collective effort of my colleagues in the Airborne Mineral Surveys and Exploration wing of the Geological Survey of India, to all of whom I am deeply grateful for their cooperation and enthusiasm. My warm thanks are due to K. Jacob who organised this project and gave advice and encouragement. G. C. Heikes, project manager of Parsons Corporation, Los Angeles, and the technical personnel of Aero Service Corporation of Philadelphia and Parsons Corporation deserve thanks for their contribution to this project. My colleagues, S. K. Ramaswamy, B. Srikantan, P. M. Mathew, A. K. Raina, J. G. Krishnamurthy, S. K. Srivastava, A. K. Wahi and D D. Yellur, offered helpful criticism during the preparation of this paper.

REFERENCES

Krishnan, M. S., 1968. Geology of India and Burma. Higginbothams Ltd., Madras, 536 p.
Pemberton, R. H., 1962. Airborne electromagnetics in review. Geophysics, 27, No. 5, p. 691-713.
Pemberton, R. H., and Seigel, H. O., 1968. Canadian geophysical technology applications and limitations overseas, Mining in Canada. Sep./August, 1968, p. 69-72.
Ramachandran Nair, M., *et al.*, 1968. Experimental studies on the electromagnetic response of tilted conducting half planes to a horizontal loop prospecting system. Geo-exploration, 6, p. 207-244.

Appendix C
Who's Who, 1944-1945

Heikes, Victor Conrad (also Conard)



HEIKES, Victor Conrad (hīks), statistician; b. Dayton, O., May 21, 1867; s. William Fletcher and Lettie (Conard) H.; grad. as assayer and chemist, Colo. State Sch. of Mines, 1889; m. Anna Sellier, Oct. 25, 1899; 1 son, George Conrad. Railroad surveys, Wyo., 1888; chemist, spl. mining investigation for Rio Grande Western Ry., 1890; chemist, La Gran Fundicion Nacional Mexicana, Monterey, Mex., 1891; asst. and chief, Colo. mining dept., Chicago Expn., 1892-93; curator economic geology, Field Columbian Museum, Chicago, 1894; supt. of mill, Sunshine Gold Mining Co., Utah, 1895-96; chemist, Mingo Smelter, Utah, 1896; mem. firm Watts & Heikes, assayers and chemists, Boulder, Colo., 1897-99; spl. agt., asst. and acting dir. mines and metallurgy, U.S. Commn. to Paris Expn., 1899-1900; field asst. Div. of Mineral Resources, U.S. Geol. Survey, 1901; chief clk., 1902, asst. chief, 1903-04; Dept. Mines and Metallurgy, St. Louis Expn.; statistician in charge Salt Lake Region branch U.S. Geol. Survey, 1904-25; engr. in charge Salt Lake sect. mineral resources and statistics, including Ariz., Ida., Mont., Nev., Utah and Wash., 1925-27; in charge mine production statistics of Calif. and Ore., San Francisco office of U.S. Bur. of Mines, 1928-33 (retired). Mem. Am. Inst. Mining and Metall. Engrs. Author (with G. F. Loughlin) of treatises on arsenic, bismuth, selenium, tellurium; also on platinum and allied metals. Mason. Home: Carmel, Calif.

INDEX--George Conrad Heikes

AFL-CIO, 37
Agency for International Development, Korea, 61-71
aluminum-magnesium division, War Production Board, 39-43
aluminum reduction plant, Tacoma, Washington, 37-39
American Smelting and Refining Company [ASARCO], 35
Anaconda Company, 9-24
Anaconda Mine, Butte, Montana, 10-14
Anvil Mine, Canada, 54
Arabian gold mine, 35
Atkinson, Bob 46
Australian mines, 59, 72

Barite Corporation, 29
bauxite mining, Greece, 51
Beeson, Desdemona, 32
Berrian, Chauncey, 15
Boleo mine, Baja California, 1
BOR mine, Serbia, 1
Boutwell, John, 5
Boyd, James, 32
Bunker, Arthur, 38-39

Calumet and Arizona Mine, 32
Caselton, Jim, 28
Cates, Louis, 4, 37
Chauvenet, Regis, 3
Church, John, 30
Cochran, Kenneth, 32
Colorado School of Mines, Golden, Colorado, 2, 3
Continental Materials Corporation, 72-74
Cooke, H. R., 55
Copper Queen Mine, Arizona, 3
copper-zinc branch, Office of Production Management, 31
Cyprus Mines Company, 54

de Chetelat, Enzo, 44, 52

Defense Materials Procurement Agency [DMPA], Region IV, 52-53
Depression, 1930s, 27-28
Dern, George, 24-25
Douglas, James, 32, 36, 52-53
Dwyer, [ ], 37

Economic Cooperation Administration (Marshall Plan), Greece, 47-52
Elfred, Stillman, 36-37
Engineering and Mining Journal [E&MJ], 6

Freshman, Walter, 10

Gaethke, Frederick P., 15
Gerard, Jimmy, 45
Gerdetz, Louis, 26-27
Gidel, Murl, 11, 14, 15
Gidwitz, Gerald, 73-74
Giesche Mines, Poland, 14-19
Gowen, J.B., 11
Grasselli Chemical Company, 6
Gray, Anton, 46
Greece, mining division, Economic Cooperation Administration, 47-52

Hanchett, Lafayette, 4
Heikes, George Conrad,
  Agency for International Development, U.S. Operations Mission, Korea, head of mining division, 61-71
  Anaconda Company, geologist, 9-25
  Economic Cooperation Administration (Marshall Plan),
    Greece, head of mining division, 47-52
  family and education, 1-8
  Mines, Inc., vice president, 44-46

Hiekes, George Conrad (cont.)
  National Lead Company, chief geologist, 28-31
  Ralph M. Parsons Company, mining geologist, 53-60
  War Production Board,
    head of aluminum-magnesium division, 39-43
    head of zinc division, 32-37
Heikes, Myung Ja Yu [Mrs. George], 58-59, 70-71
Heikes, Ruth Margaret Chapman Judd [Mrs. George], 22-24, 39-40, 58, 70
Heikes, Victor Conard, 2, 4
Heikes, William Fletcher, 3
Hess, Frank, 5
Hewett, Donnel Foster, 5

India, mineral survey, 54-58
International Universal Exhibition, Paris, 1-3

Jackling, Daniel C., 4-5
Jenkins, Ray, 54
Judd, Barbara, 22-24, 28-29
Judd, Ruth Margaret Chapman [Mrs. George Heikes], 22-24, 39-40, 58, 70
Judd, Thomas, 22-24, 28-29, 39-40
Judge, eletrolytic zinc plant, Park City, Utah, 6
Just, Evan, 31, 52, 79-80

Kalunite company, 37
Kennecott Copper Company, 46-47
Kerrigan, Jim, 11
Klepetko, Ernest, 15
Korea, Agency for International Development, 61-70
Krug, J.A."Cap", 42-43

Laist, Frederick, 14, 22
Lehigh University, Bethlehem, Pennsylvania, 5-7
Leith, C.K., 30
Leonard Mine, Butte, Montana, 10
Lindgren, Waldemar, 2, 5
Lindsley, Thayer, 42, 44-46, 77-79
Loma Prieta earthquake, 27, 55
Lund, Richard J., 27

MacPherson, [ ], 52
Marshall Plan, in Greece, 47-52
McCabe, Bill, 32-33
McGlone, Eddy, 10
McQuiston, Frank Woods, 36
Messner, Martin, 15
mines
  Anaconda, Butte, Montana, 10-14
  Anvil, Canada, 54
  barite, El Portal, California, 29
  Boleo, Baja California, 1
  BOR, Serbia, 1
  Calumet and Arizona, Bisbee, Arizona, 32
  coal mines in Poland, 19-22
  Copper Queen, Arizona, 3
  Giesche zinc and lead mine, Poland, 14-19
  gold, in Arabia, 35
  Greek, 47-52
  Leonard, Butte, Montana, 10
  Utah Copper, 4
  Zellidja, Morocco, 44-46
Moss, Milton, 3-4, 7

National Lead Company, 28-31
Nolan, Thomas B., 5

Olin Company, 37
Oracle Ridge Mine, Arizona, 72-74

Page, Walter, 32, 36
Paris Exposition (International Universal Exhibition of 1900), 1-3
Parsons, Ralph M. Company, 53-59, 72
Partnerships Pacific, 59, 72
Perry, Vincent, 11
Phelps Dodge, 4, 32-33
Pierce Management Company, 62, 68

Phelps Dodge, 4, 32-33
Pierce Management Company, 62, 68

Reading Coal and Iron Company, 26-27
Richards, Jospeh W., 5
Richardson, James K., 39
Rothschild mining interests, 1, 3

Sales, Reno, 9, 11, 14, 22
Sellier, Anna Marie, 2, 3
Sellier, Louis Jules, 1-3
Sillman, Jack F. B., 55
Soderberg aluminum reduction process, 39
Stannard, [ ], 37
Steele, Chester, 11
Subramaniam, A.P., 55-56
Sunshine Mill, Mercur, Utah, 4

Tacoma Aluminum Company, 37-39
Torgerson, Earl O., 62
Trilsch, Myron, 32, 36-37
Tynan, Mary Frances, 46

Uebelacker, David A., 31, 34

United States Agency for International Development, Korea, 61-71
United States Bureau of Mines, 27-28
United States Office of Production Management, copper-zinc branch, 31
United States Operations Mission-Korea, mining division, 61-71
United States War Production Board,
   aluminum-magnesium division, 39-43
   zinc division, 32-37
Utah Construction Company, 62, 68

Vanderburg, John, 52
Ventures, Limited, 44-46, 77-79

War Production Board,
   aluminum-magnesium division, 39-43
   zinc division, 32-37
Wegner, Gilbert, 15
Weysser, John J.L.G., 62
Wilson, Thomas Bayne, 52
Works Progress Administration [WPA], 27-28
Wright, Charles Will, 5, 47

Young, George J., 6
Young, Howard, 37

Zellidja Mine, Morocco, 44-46
Zimmer, Ben, 37
zinc division, War Production Board, 32-37
zinc mine,
   Giesche Mine, Poland, 15-17

Eleanor Herz Swent

Born in Lead, South Dakota, where her father became chief metallurgist for the Homestake Mining Company. Her mother was a high school geology teacher before marriage.

Attended schools in Lead, South Dakota. Dana Hall School, and Wellesley College, Wellesley, Massachusetts. Phi Beta Kappa. M.A. in English, University of Denver. Assistant to the President, Elmira College, New York. Married to Langan Waterman Swent, mining engineer.

Since marriage has lived in Tayoltita, Durango, Mexico; Lead, South Dakota; Grants, New Mexico; Piedmont, California.

Teacher of English as a Second Language to adults in the Oakland, California public schools. Author of an independent oral history project, Newcomers to the East Bay, interviews with Asian refugees and immigrants. Oral historian for the Oakland Neighborhood History Project.

Interviewer, Regional Oral History Office since 1985, specializing in mining history.

126313

U. C. BERKELEY LIBRARIES

C040768285